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Progress and inequalities in financial risk protection toward universal health coverage: insights from Vietnam

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Abstract

Background Financial risk protection (FRP) is central to Universal Health Coverage (UHC), aiming to shield individuals from financial hardship when accessing essential healthcare services. This study estimates trends and projections for FRP indicators in Vietnam from 2010 to 2030 at both national and sub-national levels, assesses the probability of achieving UHC targets, and analyses demographic-, geographic-, and socioeconomic-related inequalities.

Methods Data from 168,812 households collected in six nationally representative surveys (2010–2020) were analysed. FRP coverage was evaluated using indicators including catastrophic health expenditure (CHE), impoverishing health expenditure (IHE), further impoverishing health expenditure (FIE), financial hardship expenditure (FHE), and the revised SDG 3.8.2 indicator, across multiple thresholds (10%, 15%, 25%, 40%). Bayesian models projected trends and estimated the probability of achieving the 2030 UHC targets. Inequality analyses using relative, slope, and concentration indices were conducted across ethnicity, dependency ratio, urban-rural residence, region, wealth quintile, and educational level.

Findings National FRP coverage was relatively high in 2020 (78.1%–94.9%), with modest improvements projected for 2030 (81.4%–95.4%). However, probabilities of achieving UHC targets remain low, with only protection from IHE showing moderate prospects (83.6%). Ethnic minorities, rural households, and those with high dependency ratios were consistently disadvantaged, especially regarding IHE and FHE. Regional disparities were pronounced, with lower coverage in Central highland and Central Coast regions, compared to the Southeast and Red River Delta regions. Significant socioeconomic inequalities persisted, disproportionately affecting the poorest and least educated groups. Inequality gaps widened over time, particularly among regions and educational levels.

Interpretation Our findings suggest that Vietnam is unlikely to achieve full financial risk protection by 2030, given modest projected improvements and low probabilities of meeting UHC targets. Persistent and widening inequalities, particularly by region and educational level, underscore the need for targeted health financing reforms that prioritize disadvantaged groups such as ethnic minorities, rural households, and those with high dependency ratios. Strengthening social health insurance, expanding fiscal space for health, and integrating financial protection policies with broader poverty reduction and social development programs will be critical for advancing equity and moving closer to UHC in Vietnam.

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Keywords Financial risk protection, Universal health coverage, Catastrophic health expenditure, Health inequalities, Bayesian projections

Introduction

Financial risk protection (FRP) is a key target in the Sustainable Development Goals (SDGs) and a critical component of the Universal Health Coverage (UHC) framework, focusing on the aspect of health equity and the ultimate target of Health for All [1]. It is defined as the ability of all people to receive the healthcare they need without facing any financial hardship, regardless of demographic, geographic, or social-economic levels [2]. People are deemed to face financial hardship from healthcare when either experiencing catastrophic health expenditure (CHE) or impoverishing health expenditure (IHE) due to out-of-pocket (OOP) payments for healthcare services. According to a recent report by the World Health Organization (WHO), there have been increases in the number of people and proportions of the population incurring financial hardship due to OOP for healthcare including both CHE and IHE over 2000–2015 [2, 3]. Specifically, there are 926.6 million people who incurred CHE and 183.2 million people pushed into poverty due to OOP globally, and the largest burdens are concentrated in low- and middle-income countries (LMICs) and Asian countries [4–6]. The slow progress in FRP poses critical barriers to achieving UHC and other disparities in health outcomes in those left-behind countries [7].

Vietnam, an LMIC in Asia, though considered a "fast-track country" for health-related outcomes in Millennium Development Goals (MDGs), still faces challenges in achieving UHC and other health-related SDGs. Our previous investigations showed the low probability of achieving the 2030 targets for reproductive, maternal, newborn, and child health (RMNCH) service coverage, and non-communicable disease (NCD) management, with the existing and increasing inequalities in health service coverage between demographic, geographic, and socioeconomic levels in Vietnam [8, 9]. Vietnam also faces challenges in achieving financial protection in its national health insurance schemes due to a relatively low level of government spending on health (43.8% in 2019) and high levels of OOP payments for health care (43.0% in 2019), despite the relatively high level of population coverage of social health insurance (SHI) at 80% in 2016 [10]. These high levels of OOP can result in delayed access to healthcare services, exacerbate the risk of households facing CHE and IHE, and increase inequity in healthcare in multiple ways [11, 12]. Despite these obstructions, the Vietnamese government proved its high commitment to achieving UHC and SDGs by 2030 with recent national health plans and strategies focusing on reforming health finance and improving social health insurance [13, 14]. Specifically, Vietnam has introduced several policy measures, including increasing government spending on health, expanding the benefit package of SHI, and piloting alternative payment models to address this challenge [15, 16]. However, sustained efforts are needed to ensure that financial protection in national health insurance schemes is achieved for all, particularly the vulnerable and disadvantaged populations, which will contribute to Vietnam's progress towards UHC and SDG.

Monitoring and evaluating progress towards UHC targets are crucial to support government and policymakers in adapting and revising national policies, and achieving this fundamental goal of human health. Specifically, tracking trends in the protection of financial risk protection (FRP) and measuring inequalities between sub-national levels are essential for evidence-based decision-making in LMICs. However, previous works lack adequate nationally representative designs to provide sufficient information for Vietnam. Earlier studies investigating the incidence of financial hardship in Vietnam used different measurements such as total consumption expenditure (TCE), non-food consumption expenditure (NFE), or capacity to pay (CTP) with diverse thresholds ranging from 10% to 40%, thus various results of financial hardship rates varying from 2.5% to 33.9% for CHE and 2.3% to 5.0% for IHE [17–19].

The present study aims to provide valuable insights into the FRP indicators in Vietnam, estimating trends and projections from 2004 to 2030 at both national and sub-national levels, and determining the probability of achieving UHC targets by 2030. We have conducted a comprehensive analysis of FRP inequalities in Vietnam, considering demographic, geographic, and socioeconomic factors and using all available measurements. Our study is based on nationally representative data, providing essential evidence-based information for policymakers to better support the attainment of UHC in Vietnam.

Methods

Data sources

In this secondary data analysis, we collected data from Vietnam Household Living Standard Surveys (VHLSS), which are nationally representative and regularly conducted every two years by the General Statistics Office (GSO). These surveys are implemented nationwide by face-to-face interviewing household heads and key commune officials to evaluate household living standards at national, regional, and provincial levels for socioeconomic development planning and policy-making support. In total, we included 168,812 households from six

survey rounds of 2010, 2012, 2014, 2016, 2018, and 2020. Detailed information on included surveys is in Supplementary Table S1, while the sampling method and participant recruitment are described elsewhere [20].

Measurement of indicators

We measured the coverage of FRP indicators based on household consumption expenditure data according to guidelines from the WHO and the World Bank [2, 21–23]. We estimated household expenditure indicators, including total consumption, food, non-food, and OOP health expenditure. Supplementary Table S2 presents OOP as a share of TCE by year and subgroup. We then calculated household poverty indicators, including the poverty line, subsistence expenditure, and capacity to pay (CTP).

Financial hardship

We assessed financial hardship indicators following the UHC framework, focusing on two main outcomes: catastrophic health expenditure (CHE) and impoverishing health expenditure (IHE), both resulting from households' OOP healthcare expenditure. CHE represents situations where a household's OOP health expenditure exceeds a specified threshold of total consumption expenditure (TCE), non-food expenditure (NFE), or capacity to pay (CTP) [1, 2, 6, 24, 25]. In this study, we analysed CHE using multiple thresholds (10%, 15%, 25%, and 40%) applied to each of these measures (TCE, NFE, and CTP). IHE occurs when OOP payments push a non-poor household below the poverty line or push an already-poor household further into poverty [5, 26]. We also defined financial hardship health expenditure (FHE) as experiencing any type of financial hardship, either CHE or IHE, due to OOP healthcare payments.

FRP indicators

FRP indicators include three measures of protection coverage: protection from CHE, IHE, and FHE. Protection from CHE is defined as the percentage of households not experiencing CHE (100% minus the CHE percentage). Similarly, protection from IHE is the percentage of households not incurring IHE, and protection from FHE refers to the percentage of households not facing any financial hardship (either CHE or IHE). We also measured the revised SDG 3.8.2 indicator, defined as the proportion of the population whose OOP health spending does not exceed 40% of their household discretionary budget (HDB) [27]. Detailed definitions and calculation methods are provided in Supplementary Tables S3–S4 and the Supplementary Methods.

Statistical analysis

Sub-national analysis

We estimated the coverage of FRP indicators for each survey year at the national level and stratified by multiple sub-national levels including demographic, geographic, and socioeconomic groups, adjusted for the complex survey design including sampling weights, clustering, and stratification [28]. Demographic levels include the household head's ethnicity (Kinh ethnicity and other minorities) and household composition including dependency level (proportion of children or elderly people). Household dependency level is calculated by ranking household dependency ratio (proportion of those aged higher than 65 and lower than 15 in a household) into tertiles (more dependent, medium, more workforce) [29]. Geographic levels include living area (rural and urban) and regional level (Northern mountainous, Red river delta, Central Coast, Central Highlands, Southeast, and Mekong river delta). Socioeconomic levels include the household head's educational level (lower than primary school, primary school, secondary school, high school, university, and higher), household educational quintile, and household wealth quintile. The household wealth quintile is calculated as asset-based wealth index by applying principal component analysis of housing asset variables, then ranking wealth score into quintiles (poorest, poorer, middle, richer, richest). Detailed process and Stata commands for principal component analysis are published elsewhere [9].

Inequality analysis

We estimated multiple indices of inequality including the relative index of inequality (RII), slope index of inequality (SII), and the concentration index of inequality (CnI) to comprehensively assess the inequality in FRP indicators. These metrics were estimated without adjustment for additional covariates and were calculated directly based on the stratifying variables, consistent with standard practice in equity analysis. The RII measures the ratio of FRP coverage between the highest and lowest categories within a comparison group (e.g., richest vs. poorest, urban vs. rural, majority vs. minority). Values close to 1 indicate no significant inequality; values > 1 indicate higher coverage among advantaged groups (pro-advantaged), and values < 1 indicate higher coverage among disadvantaged groups (pro-disadvantaged). The SII represents the absolute percentage-point difference between the top and bottom categories, where values near 0 indicate no inequality, positive values indicate pro-advantaged inequality, and negative values indicate pro-disadvantaged inequality. The CnI, ranging from − 1 to 1, reflects the magnitude of inequality across the distribution: values near 0 indicate no inequality, negative values indicate a concentration of coverage among

disadvantaged groups, and positive values indicate a concentration among advantaged groups. Detailed calculations of these inequality indices are described elsewhere [8]. Multiple dimensions of inequality were examined including the household head's ethnic group (Kinh vs. other minorities), household dependency level (more workforce vs. more dependent), living area (urban vs. rural), household wealth level (richest vs. poorest), and head's educational level (university and higher vs. lower than primary). At the regional level, we ranked regions by FRP coverage each year and calculated inequality indices between the highest- and lowest-coverage regions. Thus, RII, SII, and CnI here reflect inequalities between these extremes, providing a summary of regional disparities without attributing results to specific regions [8, 9]. In addition, we investigated the improvement in relative, absolute, and extent inequalities over the ten years 2010–2020 by calculating the absolute change in RII, SII, and CnI with 95% Confidence Intervals (CIs) and p-values for our significance judgments.

Statistical modeling and projections

We estimated the observed coverages of FRP indicators in 2010–2020 and their 95% CI, together with average annual percent change (AAPC) in over the study periods. We then applied Bayesian binomial logistic regression with FRP coverage as the dependent variable and survey year as the main predictor. Let p_i be the observed coverage for indicator *i*, where $i \in (1, \ldots, 19)$. The logistic transformation is:

$$y_i = ln\left(\frac{p_i}{1-p_i}\right)$$

and the linear model is:

$$y_i \sim \text{Normal}(\mu_i, \sigma^2),\ \mu_i = \alpha + \beta X\prime_i$$

Where X' includes continuous time, dummy variables for ethnic group, dependency level, living area, wealth quintile, or educational level, and interaction terms between time and these variables, which is tested the inclusion using the leave-one-out cross-validation method [30]. Details of model covariate inclusions are in Supplementary Tables S5-S10. The priors for model parameters were specified as:

$$\alpha \sim Student_3\,(median(y_i),\ 10)\,,$$
$$\beta \sim\ 1\ \ (flat)\,, \sigma \sim Student_3\,(0,\ 10)$$

For regional level, we extended this model to mixed effects model, specification with varying intercepts α_j and slopes β_j by region:

$$\mu_{ij} = \alpha + \alpha_j + (\beta + \beta_j)\, x_{ij}$$

$$\begin{bmatrix}\alpha_j \\ \beta_j\end{bmatrix} \sim \text{MVNormal}\left(\begin{bmatrix}0 \\ 0\end{bmatrix}, S\right),$$

$$S = \begin{pmatrix}\sigma^2_{\alpha_i} & \sigma_{\alpha_j}\sigma_{\beta_j}\rho \\ \sigma_{\alpha_j}\sigma_{\beta_j}\rho & \sigma^2_{\beta_j}\end{pmatrix}$$

with non-informative priors α, β∼ Normal(0, 4) alpha, σ given a Half-Cauchy prior, and the correlation matrix **M** assigned an LKJ-Correlation prior. In total, 270 models were fitted using MCMC (16,000 iterations: 5,000 samples, 1,000 burn-in, four chains). Model diagnostics included the potential scale reduction factor and trace plots. Based on posterior predictive distributions, we calculated the probability of achieving UHC targets by 2030, defining achievement as ≥ 95% coverage.

Sensitivity analysis

We performed a sensitivity analysis of other measurements of wealth indices, including the income-based and expenditure-based wealth indices, which are calculated by ranking household income and consumption expenditure into quintiles, respectively. We modelled those wealth indices to produce projections and analysed the inequalities in FRP indicators between those subgroups, then compared results with those of the selected index (asset-based wealth index).

All statistical analyses were performed in R (version 4.1.1).

Results

Table 1 presents the national estimates of FRP indicators in Vietnam based on observed data from 2010, 2016, and 2020, and projections derived from our models for 2025 and 2030. The latest survey conducted in 2020 revealed relatively low coverage of protection from FHE, ranging from 54.5% to 85.8%, while the projections for 2030 anticipate coverage ranging from 59.6% to 91.3%. With such slow progress, the probability of achieving targets of 95% by 2030 for protection from FHE is remarkedly low at the national level. Moreover, our analysis reveals significant negative AAPC during the period 2010–2016 for most FRP indicators, followed by positive AAPC during 2016–2020. These trends indicate notable fluctuations in the coverage of FRP indicators between 2010 and 2020 in Vietnam.

Figure 1 presents the current estimates of all FRP indicators, stratified by the household head's ethnic group (A), household dependency level (B), and living area (C), for the years 2010, 2020, and projected values for 2030. Detailed results of the stratified analyses by ethnic group, household dependency level, and living area can

Table 1 National coverage of financial risk protection in Vietnam from 2010–2030, and probability of achieving the 2030 targets

Indicators	Estimated coverage 2010–2020					Predicted coverage to 2030		
	Year 2010 (95% CI)	Year 2016 (95% CI)	Year 2020 (95% CI)	AAPC 2010–2016 (95% CI)	AAPC 2016–2020 (95% CI)	Year 2025 (95% CrI)	Year 2030 (95% CrI)	% reach target
Protection from CHE (25% of CTP)	79.1 (78.2 to 80.0)	75.1 (74.1 to 76.2)	78.1 (77.1 to 79.1)	-0.7 (-0.9 to -0.5)*	0.8 (0.5 to 1)*	81.4 (80.3 to 82.4)	84.3 (82.6 to 85.8)	0.0
Protection from CHE (40% of CTP)	89.4 (88.7 to 90.1)	86.8 (85.9 to 87.5)	89.6 (88.8 to 90.3)	-0.4 (-0.6 to -0.3)*	0.7 (0.5 to 0.9)*	92.2 (91.5 to 92.9)	94.2 (93.3 to 95.1)	4.5
Protection from CHE (10% of TCE)	61.7 (60.5 to 62.8)	56.7 (55.5 to 57.9)	56.6 (55.3 to 57.9)	-0.8 (-1.1 to -0.6)*	0 (-0.3 to 0.2)	58.5 (57.0 to 59.9)	60.8 (58.3 to 63.3)	0.0
Protection from CHE (15% of TCE)	73.6 (72.6 to 74.6)	70.0 (68.9 to 71.1)	71.5 (70.4 to 72.7)	-0.6 (-0.8 to -0.4)*	0.4 (0.1 to 0.6)*	75.0 (73.8 to 76.3)	78.7 (76.7 to 80.5)	0.0
Protection from CHE (25% of TCE)	85.0 (84.1 to 85.7)	82.7 (81.8 to 83.6)	85.8 (85.0 to 86.6)	-0.4 (-0.6 to -0.2)*	0.8 (0.6 to 1)*	89.9 (89.1 to 90.6)	93.2 (92.2 to 94.0)	0.0
Protection from CHE (25% of NFE)	60.9 (59.8 to 62.0)	61.8 (60.6 to 63.0)	63.6 (62.4 to 64.9)	0.2 (-0.1 to 0.4)	0.5 (0.2 to 0.7)*	65.9 (64.5 to 67.3)	68.0 (65.7 to 70.3)	0.0
Protection from CHE (40% of NFE)	72.8 (71.8 to 73.8)	73.3 (72.2 to 74.4)	76.5 (75.4 to 77.5)	0.1 (-0.1 to 0.3)	0.8 (0.5 to 1)*	80.0 (78.9 to 81.1)	83.1 (81.4 to 84.7)	0.0
Protection from IHE	94.8 (94.2 to 95.3)	93.3 (92.6 to 93.9)	94.9 (94.3 to 95.4)	-0.3 (-0.4 to -0.1)*	0.4 (0.3 to 0.5)*	95.4 (94.7 to 96.0)	95.5 (94.4 to 96.5)	83.6
Protection from FHE (40% of HDB)	80.5 (79.5 to 81.4)	77.3 (76.3 to 78.4)	81.4 (80.4 to 82.3)	-0.5 (-0.7 to -0.3)*	1 (0.8 to 1.2)*	84.6 (83.6 to 85.5)	87.0 (85.4 to 88.4)	0.0
Protection from FHE (25% of CTP)	75.8 (74.9 to 76.8)	71.5 (70.4 to 72.6)	75.5 (74.4 to 76.6)	-0.7 (-0.9 to -0.5)*	1 (0.7 to 1.2)*	79.5 (78.3 to 80.5)	82.8 (81.1 to 84.4)	0.0
Protection from FHE (40% of CTP)	85.3 (84.5 to 86.1)	82.0 (81.1 to 83.0)	85.8 (85.0 to 86.7)	-0.6 (-0.7 to -0.4)*	0.9 (0.7 to 1.2)*	89.0 (88.1 to 89.8)	91.3 (90.1 to 92.4)	0.0
Protection from FHE (10% of TCE)	59.2 (58.0 to 60.3)	53.9 (52.7 to 55.1)	54.5 (53.2 to 55.8)	-0.9 (-1.1 to -0.6)*	0.2 (-0.1 to 0.4)	56.8 (55.4 to 58.3)	59.6 (57.1 to 62.0)	0.0
Protection from FHE (15% of TCE)	70.3 (69.3 to 71.4)	66.2 (65.0 to 67.4)	68.9 (67.7 to 70.0)	-0.7 (-0.9 to -0.5)*	0.7 (0.4 to 0.9)*	73.1 (71.8 to 74.3)	77.2 (75.1 to 79.0)	0.0
Protection from FHE (25% of TCE)	80.9 (80.0 to 81.8)	77.9 (76.9 to 78.9)	82.1 (81.2 to 83.0)	-0.5 (-0.7 to -0.3)*	1 (0.8 to 1.3)*	86.8 (85.9 to 87.6)	90.5 (89.3 to 91.6)	0.0
Protection from FHE (25% of NFE)	58.5 (57.4 to 59.6)	58.9 (57.6 to 60.1)	61.6 (60.3 to 62.9)	0.1 (-0.2 to 0.3)	0.7 (0.4 to 1)*	64.7 (63.3 to 66.1)	67.7 (65.3 to 69.9)	0.0
Protection from FHE (40% of NFE)	69.7 (68.6 to 70.7)	69.5 (68.4 to 70.7)	73.6 (72.5 to 74.7)	0 (-0.2 to 0.2)	1 (0.8 to 1.3)*	77.8 (76.6 to 78.9)	81.3 (79.5 to 83.0)	0.0

† WHO's targets of 100% financial risk protection for the entire population by 2030 for Universal Health Coverage. However, the beta regression models may not allow prediction of 100%, thus we use a target of 95%; CI = Confidence Interval; CrI = Credible Interval; AAPC = Average annual percentage change; The observed coverages during 2010–2020 were calculated based on the original datasets; The predicted coverages during 2020–2030 were estimated from Bayesian models; CTP = Capacity to pay; TCE = Total consumption expenditure; NFE = Non-food expenditure; HDB = Household discretionary budget; CHE = Catastrophic health expenditures; IHE = Impoverishing health expenditures; FHE = Financial hardship health expenditures; The results of sub-national levels during 2010–2030 are in the Supplementary

be found in Supplementary Tables S10–S12. Our analysis reveals notable disparities in the latest survey conducted in 2020, with households belonging to ethnic minorities, those with higher dependency levels, or residing in rural areas face considerable challenges in achieving adequate FRP indicators. We predict limited progress towards achieving the 2030 targets for all FRP indicators at the sub-national level, irrespective of ethnic group, household dependency level, or living area. An exception is observed for protection from CHE, with projected thresholds of 40% CTP, 25% TCE, and 40% NFE (Supplementary Tables S11–S13).

Figure 2 shows the estimates of all FRP indicators stratified by regional level (A), wealth quintile (B), and head's educational level (C) in the years 2010, 2020 and projections to 2030. The details of stratified analyses by regional level, educational level, and wealth quintile are in Supplementary Tables S13–S15. Regarding the regional level, we observe diversities in the coverages of FRP indicators between regions. While the Northern mountainous and Central highland regions will be left behind, the Southeast and Red River Delta regions will have the highest coverage in most FRP indicators. Nevertheless, except for protection from CHE with high-level thresholds (i.e., 40% CTP, 25% TCE, and 40% NFE), no FRP indicators showed the likelihood of achieving 2030 targets in any region (Supplementary Table S14). Regarding socioeconomic levels (i.e., wealth quintile and educational level), households those are most impoverished (poorest and poorer quintile) and lowest educational levels (lower

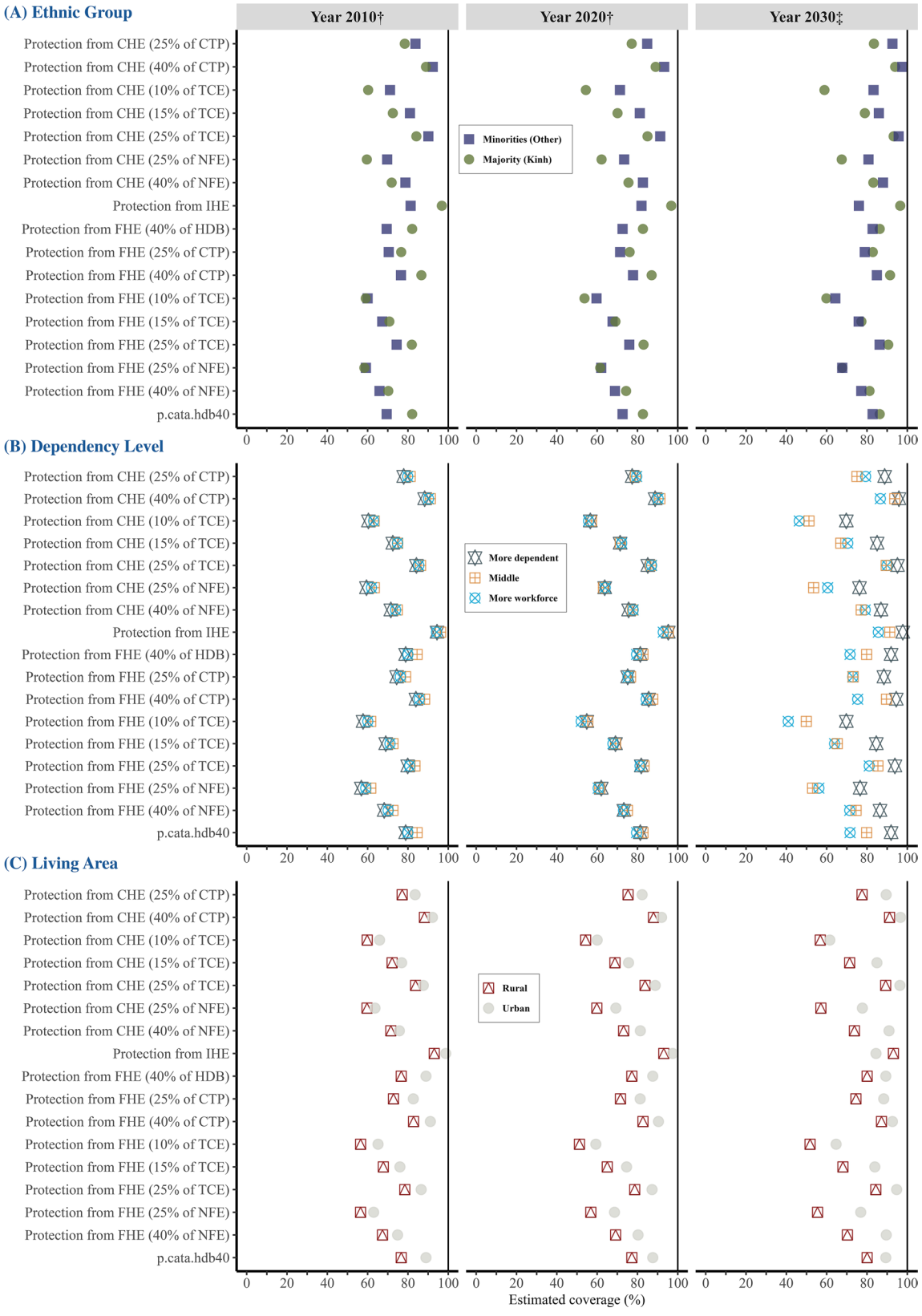

Fig. 1 (See legend on next page.)

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Fig. 1 Observations and projections of Financial risk protection indicators in Vietnam by (**A**) Ethnic group; (**B**) Dependency level; and (**C**) Living area † Estimation from observed data in 2010 and 2020; ‡ Projections from Bayesian models; CTP = Capacity to pay; TCE = Total consumption expenditure; NFE = Non-food expenditure; HDB = Household discretionary budget; CHE = Catastrophic health expenditures; IHE = Impoverishing health expenditures; FHE = Financial hardship health expenditures; The coloured shapes are the estimated and projected values for sub-national levels; the horizontal axis shows coverage scales from 0–100%

than primary and primary school) will be left behind in most indicators, with the largest gaps observed in indicators of protection from IHE and FHE (Supplementary Tables S15–S16). In contrast, while we predicted no achievement of 2030 targets for most FRP indicators in any wealth quintile and educational level, the richest and most educated households will be able to reach the 2030 targets in some indicators of protection from CHE. Supplementary Figures S1–S15 present the trends in and projections of all FRP indicators at sub-national levels, including ethnic group, dependency level, living area, regional level, wealth quintile, and educational level. Our sensitivity analysis showed comparable trends and projections of FRP indicators stratified by the asset- and income-based wealth indices while they are unmatched by the expenditure-based wealth index (Supplementary Tables S16-S18, Figure S16).

Table 2 presents the relative, slope, and concentration indices of demographic-, geographic-, and socioeconomic-related inequality in main FRP indicators, including protection from CHE (25% of CTP), protection from IHE, and protection from FHE (25% of CTP) in 2010 and 2020 in Vietnam. The comprehensive inequality analyses of all FRP indicators and all survey years are shown in Supplementary Table S19. We observed statistically significant inequalities in FRP indicators across all indices (RII, SII, and CnI), with most indicators showing lower FRP coverage among disadvantaged groups (e.g., RII > 1, SII > 0, CnI > 0), although the magnitude of inequalities varied by stratifying variables. Across all inequality sites, the largest gaps are more likely to be observed in indicators of protection from IHE and protection from FHE. On the other hand, over FRP indicators, the largest extents of inequality are seen between wealth quintiles, educational levels, ethnic groups, and urban-rural areas.

The percentage changes of inequalities in selected FRP indicators from 2010 – 2020 with 95% CI and notations for p-values are in Table 2, and the percentage changes of inequality in all FRP indicators are in Supplementary Table S20. Figure 3 visualizes the changes in FRP indicators in all inequality indices (RII, SII, and CnI) from 2010 – 2020 for ethnic group, dependency level, living area, regional level, wealth quintile, and educational level. In each panel, the bottom-left quadrant shows the indicators with significant improvements (reductions) in all three dimensions (relative, absolute, and magnitude terms) of inequalities, while the top-right quadrant contains the indicators with increasing inequalities between subgroups. Specifically, we observed significant improvements in inequalities across most FRP indicators between ethnic groups, living areas, dependency levels (except protection from CHE), and wealth quintiles (except protection from IHE) in Vietnam during 2010–2020. In contrast, inequalities increased across all FRP indicators for educational and regional levels, as reflected in their position in the top-right quadrant. Our sensitivity analysis for comparing changes in inequalities in all indicators of protection from CHE and FHE at different thresholds are in Supplementary Figure S17–S18.

Discussion

This study is the first and most comprehensive work investigating the financial risk protections in healthcare in Vietnam and progress toward UHC targets. We predict that most of the FRP indicators will not achieve the 2030 targets of 100% coverage at either national or sub-national levels due to the modest progress over 2010–2020. In sub-national analysis, we showed that the most disadvantaged groups are left behind in being protected from financial risk in healthcare, including those who are ethnic minorities or have more dependents, live in rural or some less developed regions, or have lower levels of socioeconomic status. Our inequality analysis confirmed the significance of these demographic-, geographic-, and socioeconomic-related inequalities in FRP with widening gaps between ethnic groups and regional levels, which will be the barriers to the achievement of UHC in Vietnam.

In this study, we estimated and projected the FRP indicators including protection from CHE, IHE, and FHE in Vietnam at the national level from 2010 to 2030, which are relatively comparable with the global literature on financial protection in Asian LMICs [31, 32]. We, however, showed the levelling off or slightly increasing trends in most FRP indicators in Vietnam, which are in contrast with the reported decreasing trends in other countries [2, 5, 6]. These results may suggest some impacts of the rapid economic growth and reformed health financing policies in Vietnam. Indeed, the economic reforms since Đổi Mới in 1986 (from a highly centralized command economy to market-oriented mechanisms) helped Vietnam increase its GDP per capita (reaching US$3700 in 2021), declining poverty rates, and transiting into a middle-income economy in a couple of decades [33]. Vietnam has showed great economic resilience through different crises, including COVID-19, with an expected GDP growth rate

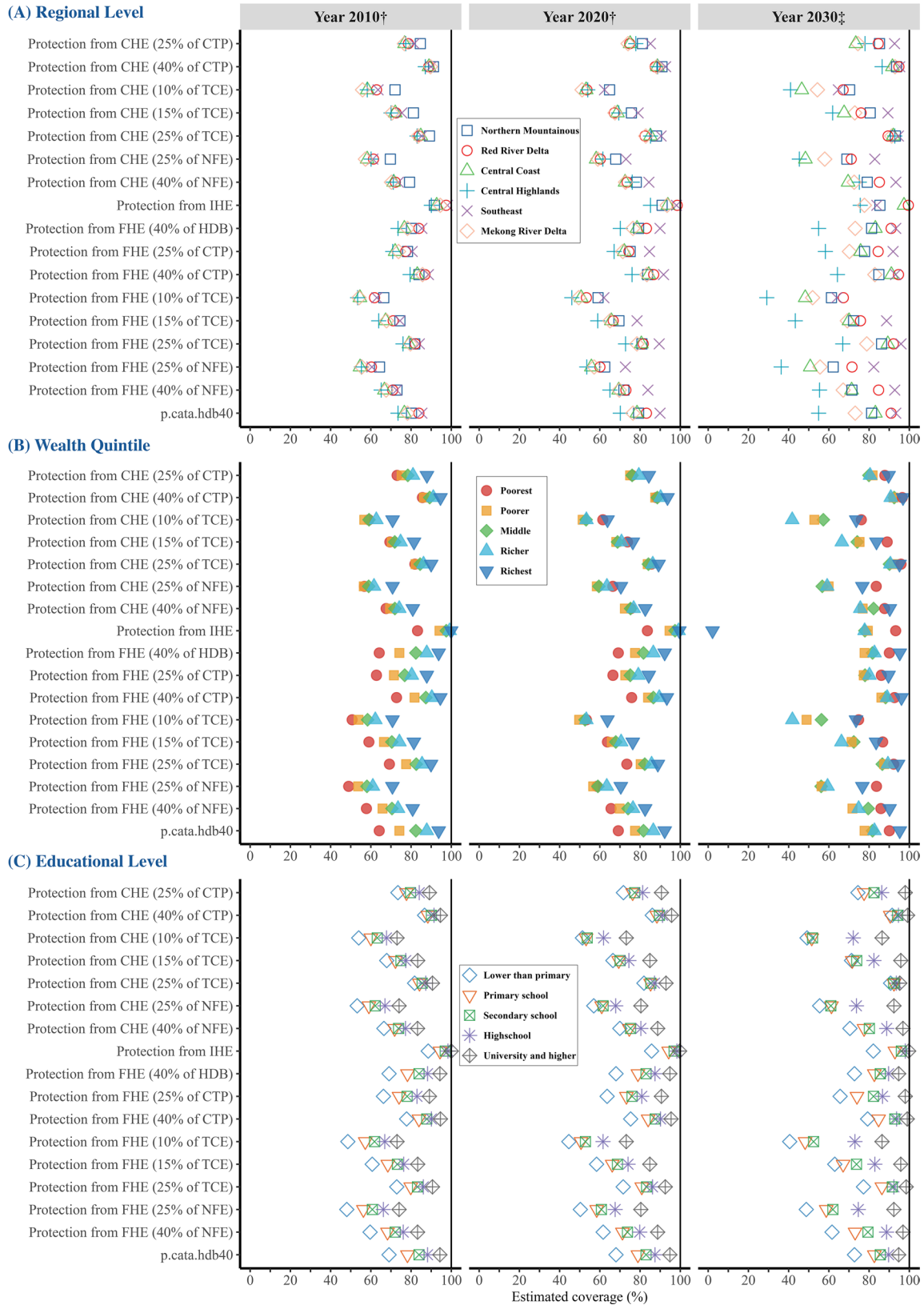

Fig. 2 (See legend on next page.)

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Fig. 2 Observations and projections of Financial risk protection indicators in Vietnam by (**A**) Regional level; (**B**) Wealth quintile; and (**C**) Educational level. † Estimation from observed data in 2010 and 2020; ‡ Projections from Bayesian models; CTP = Capacity to pay; TCE = Total consumption expenditure; NFE = Non-food expenditure; HDB = Household discretionary budget; CHE = Catastrophic health expenditures; IHE = Impoverishing health expenditures; FHE = Financial hardship health expenditures; The coloured shapes are the estimated and projected values for sub-national levels; the horizontal axis shows coverage scales from 0–100%

of 7.2% in 2022, thanks to the solid foundations in the economic and healthcare system [33–35]. Additionally, there have been several critical policies reforming the healthcare system in Vietnam, including the Health care fund for the poor in 2002, the Social health insurance (SHI) law in 2009, and SHI law amendments in 2015, to shift government's focus to demand-side subsidies, provide health insurance for some disadvantaged groups (i.e., the poor, near poor, ethnic minorities, elders over 80, children under 6, and the meritorious), and enhance the financial protection capacity of the healthcare system [36, 37].

On the other hand, despite these positive signals, we predicted a very low probability of reaching the UHC targets by 2030 at the national level in Vietnam with no significant improvements in most of the FRP indicators over 2020–2030. This could be linked to the other side of a market economy with accelerating demand for and expenditure on healthcare due to potential negative impacts of the implementations of hospital autonomy and fee-for-service mechanisms, and the expansions of the private healthcare sector with indiscriminate use of high-technology medical devices [38, 39]. In addition, although Vietnam doubled its GDP during 2010–2020, there has been inadequate public investment in health with unchanged national health expenditure in the same period (ranging from 4.7% to 5.3% GDP) and a high level of OOP payments (about 41% national health expenditure), which could raise household's OOP and induce further inequalities to healthcare accessibility [40, 41]. As UHC achievements require long-term policy engagement of both technical knowledge and political know-how, our findings call for more attention and efforts from the government of Vietnam to continue reforming health financing policies and enhancing the ability of financial protection in the healthcare system [42].

Realizing the importance of measuring variations in FRP indicators across population groups, we provided comprehensive estimates at sub-national levels and showed that disadvantaged households (ethnic minorities, have more dependent, live in rural areas, live in less economically developed regions, the poor, and the least educated) are lagging behind in most of the FRP indicators in Vietnam, which agrees with previous works [25, 43]. Our inequality analysis confirmed the significant inequalities in FRP protections between demographic, geographic, and socioeconomic groups with increasing inequalities observed in ethnic groups and regional levels. This result may be related to the disparities in poverty between geographic levels with higher poverty rates among ethnic minorities and some less economically developed regions (e.g., Northern mountainous and Central highland regions) [44]. Previous works showed the shortage in human resource quantity and quality in the healthcare system in mountainous areas, and the work-related stress due to effort-reward imbalance recorded among healthcare staff in Vietnam [45, 46]. Additionally, our study could propose the modest effectiveness of a healthcare funds in providing financial protection for the poor or for ethnic minorities living in selected mountainous province [47]. Our stratified analyses further showed that ethnic or regional inequalities in FRP were insignificant when stratifying by wealth quintile or educational level, suggesting the important role of socioeconomic interventions/programs in reducing FRP inequalities in Vietnam.

Ultimately, healthcare financing reforms with a focus on risk-pooling mechanisms through SHI schemes play a key role in increasing coverage of and improving inequality in FRP and UHC, by enabling lower-need (healthier and/or richer) individuals to subsidize higher-need (sicker and/or poorer) individuals [12, 48, 49]. Recent reviews proposed that core interventions for the attainment of FRP should include pooling arrangements, expansion of insurance coverage, and financial incentives [50, 51]. In Vietnam, SHI has reformed through five stages of development since 1992, with great achievements in all three dimensions of UHC including the breadth (population coverage), the depth (service coverage), and the height (cost sharing). Specifically, the coverage has been rapidly expanded (from 47.8% in 2008 to 80% in 2016) [52], with a generous benefits package (inclusion of expensive medications, e.g., HIV/AIDS treatment) [53–55], and government subsidies to 16 disadvantaged groups (totally and partially) to encourage individual enrolment [56, 57]. However, there are still several challenges on the path toward universal coverage of SHI (including the sustainability of SHI schemes and the cross-subsidization mechanism), and concerns regarding the effectiveness of SHI in protecting disadvantaged households from financial hardship [58, 59]. Again, achieving all financial risk protection targets is vital to progress toward UHC because the availability and quality of health services will be fruitless if they are inaccessible and unaffordable to people in need. Thus, our inequality analyses warrant more attention and efforts from the

Table 2 Demographic-, geographic-, and socioeconomic-related inequalities in FRP coverage and changes in 2010–2020 in Vietnam

Inequalities	Indicators	Year 2010			Year 2020			Changes in 2010–2020 (%)		
		RII	SII	CnI	RII	SII	CnI	RII	SII	CnI
Ethnic inequality	Protection from CHE (25% of CTP)	0.84 (0.80 to 0.88)***	-14.11 (-18.15 to -10.06)***	-0.013 (-0.016 to -0.009)***	0.77 (0.76 to 0.79)***	-20.58 (-22.36 to -18.81)***	-0.019 (-0.021 to -0.017)***	-0.07 (-0.12 to -0.01)**	-6.48 (-10.89 to -2.06)**	-0.007 (-0.011 to -0.002)**
	Protection from IHE	1.41 (1.34 to 1.48)***	30.53 (26.57 to 34.49)***	0.023 (0.021 to 0.025)***	1.39 (1.36 to 1.42)***	29.22 (27.46 to 30.97)***	0.022 (0.022 to 0.023)***	-0.02 (-0.07 to 0.03)	-1.31 (-5.64 to 3.02)	-0.000 (-0.002 to 0.002)
	Protection from FHE (25% of CTP)	1.13 (1.06 to 1.21)***	9.29 (4.39 to 14.20)***	0.009 (0.004 to 0.013)***	1.07 (1.04 to 1.10)***	4.89 (2.70 to 7.07)***	0.005 (0.003 to 0.007)***	-0.07 (-0.14 to 0.01)	-4.40 (-9.77 to 0.96)	-0.004 (-0.009 to 0.001)
Dependency inequality	Protection from CHE (25% of CTP)	1.05 (1.01 to 1.09)*	3.94 (0.78 to 7.10)*	0.007 (0.001 to 0.013)*	1.06 (1.04 to 1.08)***	4.80 (3.29 to 6.30)***	0.008 (0.006 to 0.011)***	0.01 (-0.03 to 0.06)	0.86 (-2.64 to 4.36)	0.001 (-0.005 to 0.007)
	Protection from IHE	1.01 (0.99 to 1.03)	0.82 (-1.00 to 2.64)	0.001 (-0.001 to 0.004)	0.97 (0.96 to 0.98)***	-3.17 (-4.07 to -2.27)***	-0.005 (-0.006 to -0.003)***	-0.04 (-0.06 to -0.02)***	-3.99 (-6.02 to -1.96)***	-0.006 (-0.009 to -0.003)***
	Protection from FHE (25% of CTP)	1.06 (1.01 to 1.11)*	4.42 (1.07 to 7.77)*	0.008 (0.002 to 0.014)**	1.02 (1.00 to 1.04)	1.55 (-0.04 to 3.14)	0.003 (-0.000 to 0.006)	-0.04 (-0.09 to 0.01)	-2.87 (-6.58 to 0.84)	-0.006 (-0.012 to 0.001)
Urban-Rural Inequality	Protection from CHE (25% of CTP)	1.14 (1.10 to 1.20)***	10.81 (7.28 to 14.34)***	0.014 (0.009 to 0.019)***	1.13 (1.11 to 1.15)***	9.67 (8.09 to 11.25)***	0.014 (0.012 to 0.017)***	-0.01 (-0.06 to 0.04)	-1.14 (-5.01 to 2.73)	0.000 (-0.005 to 0.006)
	Protection from IHE	1.13 (1.11 to 1.15)***	11.95 (10.35 to 13.56)***	0.013 (0.011 to 0.015)***	1.11 (1.10 to 1.12)***	9.74 (8.93 to 10.56)***	0.012 (0.011 to 0.013)***	-0.03 (-0.04 to -0.01)*	-2.21 (-4.01 to -0.42)*	-0.001 (-0.004 to 0.001)
	Protection from FHE (25% of CTP)	1.27 (1.21 to 1.33)***	18.22 (14.55 to 21.89)***	0.025 (0.019 to 0.030)***	1.24 (1.21 to 1.27)***	16.24 (14.60 to 17.88)***	0.025 (0.022 to 0.028)***	-0.03 (-0.08 to 0.03)	-1.98 (-6.00 to 2.04)	0.000 (-0.006 to 0.006)
Regional Inequality	Protection from CHE (25% of CTP)	1.13 (1.09 to 1.17)***	9.39 (6.47 to 12.31)***	0.018 (0.012 to 0.024)***	1.19 (1.17 to 1.21)***	13.24 (11.90 to 14.59)***	0.027 (0.024 to 0.029)***	0.06 (0.02 to 0.10)*	3.85 (0.63 to 7.07)*	0.008 (0.002 to 0.015)*
	Protection from IHE	1.11 (1.09 to 1.12)***	9.54 (8.03 to 11.05)***	0.017 (0.014 to 0.020)***	1.13 (1.12 to 1.14)***	11.73 (11.06 to 12.40)***	0.021 (0.020 to 0.022)***	0.03 (0.01 to 0.04)**	2.19 (0.54 to 3.85)**	0.004 (0.001 to 0.008)**
	Protection from FHE (25% of CTP)	1.12 (1.07 to 1.17)***	8.41 (5.30 to 11.52)***	0.018 (0.011 to 0.025)***	1.20 (1.18 to 1.22)***	13.23 (11.81 to 14.64)***	0.028 (0.025 to 0.031)***	0.08 (0.03 to 0.13)**	4.82 (1.40 to 8.23)**	0.010 (0.002 to 0.017)**
Socioeconomic Inequality	Protection from CHE (25% of CTP)	1.22 (1.17 to 1.26)***	15.34 (12.45 to 18.24)***	0.030 (0.024 to 0.036)***	1.12 (1.10 to 1.14)***	8.54 (7.18 to 9.90)***	0.017 (0.014 to 0.020)***	-0.10 (-0.14 to -0.06)***	-6.81 (-10.00 to -3.61)***	-0.013 (-0.020 to -0.006)***
	Protection from IHE	1.16 (1.15 to 1.18)***	14.40 (13.23 to 15.57)***	0.036 (0.033 to 0.039)***	1.17 (1.16 to 1.18)***	14.54 (13.98 to 15.10)***	0.037 (0.036 to 0.039)***	0.01 (-0.01 to 0.02)	0.14 (-1.16 to 1.44)	0.001 (-0.002 to 0.004)
	Protection from FHE (25% of CTP)	1.45 (1.39 to 1.51)***	28.14 (25.17 to 31.11)***	0.060 (0.054 to 0.067)***	1.33 (1.31 to 1.36)***	21.55 (20.16 to 22.95)***	0.047 (0.044 to 0.050)***	-0.11 (-0.16 to -0.07)***	-6.59 (-9.87 to -3.30)***	-0.013 (-0.021 to -0.006)***
Educational Inequality	Protection from CHE (25% of CTP)	1.19 (1.14 to 1.23)***	13.38 (10.45 to 16.32)***	0.026 (0.020 to 0.032)***	1.20 (1.18 to 1.22)***	13.79 (12.43 to 15.14)***	0.027 (0.024 to 0.030)***	0.01 (-0.03 to 0.05)	0.40 (-2.83 to 3.63)	0.001 (-0.006 to 0.008)
	Protection from IHE	1.14 (1.13 to 1.15)***	12.60 (11.58 to 13.62)***	0.025 (0.022 to 0.028)***	1.14 (1.14 to 1.15)***	12.87 (12.31 to 13.43)***	0.028 (0.027 to 0.029)***	0.00 (-0.01 to 0.02)	0.26 (-0.90 to 1.43)	0.003 (-0.000 to 0.006)
	Protection from FHE (25% of CTP)	1.36 (1.31 to 1.42)***	23.14 (20.10 to 26.18)***	0.048 (0.041 to 0.054)***	1.39 (1.36 to 1.41)***	24.14 (22.75 to 25.54)***	0.050 (0.047 to 0.053)***	0.03 (-0.02 to 0.07)	1.00 (-2.34 to 4.35)	0.003 (-0.004 to 0.010)

Notes: RII = Relative Index of Inequality; SII = Slope Index of Inequality; CnI = Concentrate Index of Inequality; CTP = Capacity to pay; CHE = Catastrophic health expenditures; IHE = Impoverishing health expenditures; FHE = Financial hardship health expenditures; ***, **, * Statistically significant results with $p < 0.001$, $p < 0.01$, and $p < 0.05$, respectively; CI = Confidence Interval; The inequality analyses of FRP indicators for all survey years are in the Supplementary

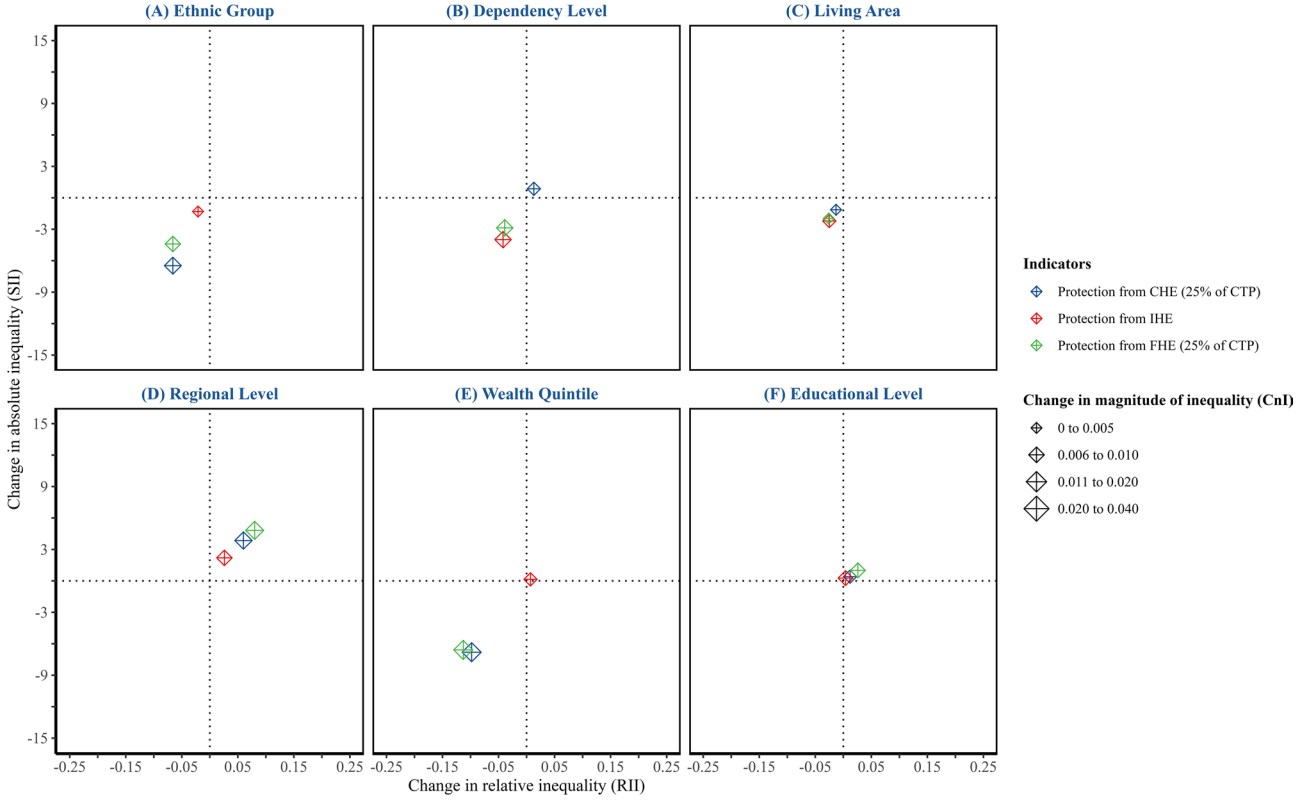

Fig. 3 Changes in inequalities in Financial risk protection from 2010–2020 in Vietnam Notes: (**A**) Ethnic inequality; (**B**) Dependency inequality; (**C**) Urban-rural inequality; (**D**) Regional inequality; (**E**) Wealth inequality; and (**F**) Educational inequality. CTP = Capacity to pay; CHE = Catastrophic health expenditures; IHE = Impoverishing health expenditures; FHE = Financial hardship health expenditures; Financial risk protection indicators are expressed as coloured diamond shapes, The horizontal and vertical axes show percentage changes in the relative index of inequality (RII) and the slope index of inequality (SII) between 2010–2020, respectively; the size of the shapes indicates the absolute percentage change in concentration index of inequality (CnI) between 2010–2020; Positive values suggest an increasing trend in inequality, and negative values express a decreasing trend in inequality

government of Vietnam in improving inequality in FRP by continue reforming the SHI system and expanding all three dimensions of coverage (population, service, and cost coverage).

Regular monitoring and evaluating FRP progress is critical for advancing toward universal coverage [12]. However, there are challenges in FRP measurements with diverse methods and thresholds, which pose difficulties in tracking and comparing the FRP progress within and between countries over time based on previous publications [43, 60]. Our study provided a comprehensive picture of trends in, projections of, and inequality in FRP indicators using multiple measurement methods and thresholds, which could support the comparison of the results between different measurements. Our trend analysis suggested that using a high-level threshold (e.g., 40%) may benefit in showing a relatively higher coverage of FRP (or lower incidence of financial hardship), but might have less sensitivity in analysing trends and tracking the improvements of FRP over time (insignificant AAPC of those high-level thresholds observed in Table 1). In contrast, our inequality analysis confirmed that measurement based on TCE may be pro-rich and bias the estimations and trends of inequalities between sub-national levels by inducing either underestimations (ethnic group, dependent level, wealth quintile) or even contrasting results (living area). Additionally, we provided a sensitivity analysis in measurements of household's wealth index and suggested the various results between asset-based, income-based, and expenditure-based indices. These findings warrant further studies to provide a method for combining information from those indicators to have the most informative wealth index.

To address inequalities in financial risk protection, policy reforms in Vietnam may benefit from moving beyond broad national targets toward strategies that better address the needs of disadvantaged groups. One possible approach is to strengthen targeting mechanisms by linking the Ministry of Labour, Invalids and Social Affairs' (MOLISA) poverty household database with the SHI enrolment system, which could facilitate automatic identification of eligible households [61]. This might be complemented by community-based outreach initiatives and mobile registration units in remote or ethnic minority areas to reduce barriers related to geography and administration. At the same time, Vietnam's demographic

context, including an aging population, rising life expectancy, and the continued prevalence of informal employment, highlights the importance of sustainable SHI financing [62]. Policymakers may wish to consider contribution models that are progressive and flexible enough to accommodate irregular incomes, while also expanding fiscal space through general taxation. Finally, in designing the health benefit package, there is scope to take into account financial protection and equity in addition to cost-effectiveness. Extended cost-effectiveness analysis provides one potential framework to support decisions that aim not only to maximize health gains but also to reduce financial hardship and narrow equity gaps [63].

The present study provides a comprehensive picture of all FRP indicators with different thresholds in Vietnam by using population-based household surveys and estimates the probabilities of achieving the UHC targets by 2030 by applying Bayesian statistics. Furthermore, we estimate patterns and trends in demographic-, geographic-, and socioeconomic-related inequalities in FRP indicators, which are in great demand for government and policymakers in revising and updating financial schemes for national healthcare programs. Still, some limitations of this work need to be mentioned. First, we projected the future coverage of FRP indicators based on the assumption of unchanged tendency from the previous period (2010–2020), which may restrict our ability to reflect the revised or newly-implemented policies/programs after the study period. However, it is widely accepted in projection studies as the findings can serve as a baseline estimate of FRP progress against which future policy changes can be measured [64, 65]. Second, the adopted non-informative priors for simplifying the modelling process of Bayesian models may induce lessening precision and thus interpretation should be made with caution. Third, our estimates capture only the financial hardship component of financial protection and do not account for care foregone due to financial barriers, which may lead to an underestimation of the true estimates of financial hardship. Third, our estimates capture only the financial hardship dimension of financial protection and do not account for foregone care due to financial barriers, which may lead to an underestimation of the true extent of financial hardship. Despite our effort to collect all the available nationally-representative data, the unavailability of post-2020 data may potentially alter the results of long-term trends and projections.

Conclusions

Our study highlights Vietnam's slow national and subnational progress in FRP indicators and persistent inequalities across demographic, geographic, and socioeconomic groups, particularly among ethnic minorities, rural populations, and disadvantaged regions. Urgent policy interventions are needed to address these widening gaps through targeted healthcare financing reforms closely integrated with broader socioeconomic and poverty reduction strategies. Strengthening monitoring, evaluation systems, and open-data initiatives will also be critical for evidence-informed policymaking. With sustained governmental commitment and targeted actions, Vietnam can realistically achieve UHC by 2030, significantly advancing national health equity.

Supplementary Information

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Supplementary Material 1

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Author contributions
P.N. and P.L. conducted the literature search and contributed to study conceptualization. P.N. developed the methodology, performed the data analysis and interpretation, and prepared the visualizations. P.N. and P.L. were responsible for data collection, original draft writing, and review and editing of the manuscript. P.L. oversaw project administration. The work reported in the paper has been performed by the authors unless otherwise specified in the text.

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Data availability
The data supporting the findings of this study are available from the General Statistics Office of Vietnam upon reasonable request.

Declarations

Ethics approval and consent to participate
This study is a secondary data analysis based on de-identified data and requires no ethical approval.

Generative AI use
The authors independently drafted, revised, and edited the manuscript. ChatGPT was used solely for minor language refinement, with all modifications carefully reviewed and approved by the authors.

Competing interests
The authors declare no competing interests.

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