Exploration of the hidden financial hardship of chronic kidney disease under universal coverage in Thailand

Pornpen Sangthawan

A Thesis Submitted in Fulfillment of the Requirements for the

Degree of Doctor of Philosophy in Health Sciences

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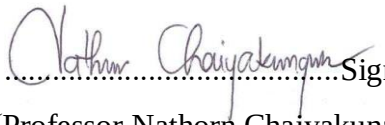
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ชื่อวิทยานิพนธ์ Exploration of the hidden financial hardship of chronic kidney disease under universal coverage in Thailand

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บทคัดย่อ

บทนำ:

โรคไตเรื้อรังเป็นโรคที่มีความชุกสูงในประเทศไทย และมีผลกระทบสำคัญต่อภาวะเศรษฐกิจทั้งในระดับผู้ป่วยและระดับประเทศ ประเทศไทยได้เริ่มนโยบายสิทธิประโยชน์ Universal Health ที่ครอบคลุมค่าใช้จ่ายในการบำบัดทดแทนไต ตั้งแต่ปี 2008 โดยผ่านทางนโยบาย PD First ซึ่งนโยบายนี้ได้รับการอ้างอิงว่าเป็นต้นแบบที่ประสบความสำเร็จในการดูแลผู้ป่วยที่เป็นโรคไตวายในประเทศที่มีรายได้ต่ำถึงปานกลาง แต่พบว่า ผู้ป่วยไทยที่เป็นโรคไตเรื้อรังยังจำเป็นต้องจ่ายค่ารักษาพยาบาลเองซึ่งอาจนำไปสู่ความล้มละลายจากค่าใช้จ่ายด้านสุขภาพและความยากจนที่เป็นผลจากการใช้จ่ายเพื่อสุขภาพได้ แต่อย่างไรก็ตามยังไม่มีข้อมูลการศึกษาถึงผลกระทบนี้ ดังนั้นการศึกษานี้มีวัตถุประสงค์เพื่อศึกษาผลกระทบทางเศรษฐศาสตร์ที่มีในผู้ป่วยโรคไตเรื้อรังที่ได้รับการรักษาภายใต้สิทธิประโยชน์ Universal Health นี้

วิธีการศึกษา:

การศึกษานี้เป็นการศึกษาพหุสถาบันแบบภาคตัดขวางในประเทศไทย ตั้งแต่ มิถุนายน 2562 ถึง มกราคม 2564 โดยมีผู้ป่วยโรคไตเรื้อรัง 1,224 ราย จาก รพ.ศูนย์และรพ.มหาวิทยาลัย ทั้งหมด 11 รพ. ผู้ป่วยที่เข้าร่วมในการวิจัยเป็นผู้ป่วยที่อยู่ภายใต้สิทธิ์การรักษา 3 สิทธิ์ ได้แก่ สิทธิประกันสุขภาพถ้วนหน้า สิทธิประกันสังคม และสิทธิกรมบัญชีกลาง ผู้ป่วยโรคไตเรื้อรังที่เข้าร่วมการวิจัย ประกอบด้วย ผู้ป่วยที่มีค่าการทำงานของไต (eGFR) 15-60 มล.ต่อนาทีต่อ 1.73 ม.^{2} (CKD15-60), ผู้ป่วยที่มีค่าการทำงานของไต (eGFR) น้อยกว่า 15 มล.ต่อนาทีต่อ 1.73 ม.^{2} (CKD<15), ผู้ป่วยที่ได้รับการล้างไตทางช่องท้อง (PD) และผู้ป่วยที่ได้รับการฟอกเลือดด้วยเครื่องไตเทียม (HD) ในการศึกษานี้ได้รวบรวมข้อมูลค่าใช้จ่ายที่ผู้ป่วยต้องจ่ายเอง ทั้งค่าใช้จ่ายตรงทางการแพทย์ และค่าใช้จ่ายตรงที่ไม่ใช่ทางการแพทย์โดยการสัมภาษณ์ผู้ป่วย มีการประเมินผลกระทบทางเศรษฐศาสตร์โดยการคำนวณสัดส่วนของผู้ป่วยที่เกิดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพ (Catastrophic Health Expenditure (CHE)) และความยากจนที่เป็นผลจากการใช้จ่ายเพื่อสุขภาพ (Medical impoverishment) และมีการเปรียบเทียบระหว่างกลุ่มของโรคไตเรื้อรัง สิทธิ์การรักษาและเศรษฐฐานะ และมีการประเมินปัจจัยที่มีผลต่อการล้มละลายจากค่าใช้จ่ายด้านสุขภาพ (CHE) โดยใช้สถิติ multivariable logistic regression model

ผลการศึกษา:

ประชากรในการศึกษานี้ ประกอบด้วย ผู้ป่วยกลุ่ม CKD15-60 435 คน (35.5%), กลุ่ม CKD<15 213 คน (17.5%), ผู้ป่วย PD 257 คน (21%) และ ผู้ป่วย HD 319 คน (26%) โดยมีอายุเฉลี่ย 63.8 ปี และ เป็นผู้หญิง 44 % ผู้ป่วยที่อยู่ในสิทธิประกันสุขภาพถ้วนหน้า สิทธิประกันสังคม และสิทธิกรมบัญชีกลาง จำนวน 44.1, 8.9 and 47% ตามลำดับ โรคร่วมที่พบบ่อยที่สุด คือความดันเลือดสูง รองลงมาเป็นไขมันในเลือดผิดปกติ เบาหวาน และโรคหัวใจและหลอดเลือด ในกลุ่มผู้ป่วยสิทธิประกันสุขภาพถ้วนหน้าและสิทธิกรมบัญชีกลาง พบว่า ผู้ป่วยที่ได้รับการฟอกเลือดด้วยเครื่องไตเทียมเป็นผู้ป่วยที่เกิดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพและความยากจนมากที่สุดโดยเฉพาะผู้ป่วยกลุ่มที่มีเศรษฐานะยากจนที่สุด ปัจจัยสำคัญที่ทำให้เกิดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพ ในผู้ป่วยที่รักษาด้วยการฟอกเลือดด้วยเครื่องไตเทียมในทุกสิทธิการรักษา คือ ค่าใช้จ่ายในการเดินทางไปรับการรักษาพยาบาล โอกาสที่เกิดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพในผู้ป่วยภายใต้สิทธิ์ประกันสุขภาพถ้วนหน้าที่ฟอกเลือดด้วยเครื่องไตเทียมสูงถึง 53% ซึ่งสูงกว่า 22% ในกลุ่มผู้ป่วยที่ได้รับการล้างไตทางช่องท้องอย่างมีนัยสำคัญทางสถิติ ปัจจัยอื่นที่เพิ่มโอกาสเกิดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพอย่างมีนัยสำคัญทางสถิติ ได้แก่ อายุ (adjusted OR = 1.027, 95%CI: 1.013-1.019), โรคหัวใจและหลอดเลือด (adjusted OR = 1.767, 95% CI:1.147-1.829) และขนาดของครอบครัวเป็นปัจจัยที่ลดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพ (adjusted OR =0.806, 95 %CI: 0.718-0.863). ผู้ป่วยโรคไตเรื้อรังจากภาคกลางของประเทศไทย เป็นกลุ่มที่เกิดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพสูงกว่าผู้ป่วยที่มาจากภาคอื่น

สรุปผลการศึกษา:

แม้ว่าผู้ป่วยโรคไตเรื้อรัง จะมีสิทธิการรักษาพยาบาลที่เป็น Universal Health แล้วก็ตาม แต่ผู้ป่วยโรคไตเรื้อรังยังมีผลกระทบทางด้านเศรษฐศาสตร์ โดยพบในผู้ป่วยโรคไตเรื้อรังที่ได้รับการบำบัดทดแทนไตสูงกว่าผู้ป่วยระยะก่อนรับการบำบัดทดแทนไต ผู้ป่วยโรคไตที่ได้รับการฟอกเลือดด้วยเครื่องไตเทียมที่อยู่ภายใต้สิทธิ์ประกันสุขภาพถ้วนหน้าเป็นกลุ่มที่เกิดการล้มละลายจากค่าใช้จ่ายด้านสุขภาพและความยากจนมากที่สุด ทั้งที่มีความจำเป็นที่ต้องได้รับการรักษาด้วยการฟอกเลือดด้วยเครื่องไตเทียม ซึ่งเป็นจุดที่ผู้วางนโยบายสิทธิ์การรักษาควรพิจารณากลยุทธ์ที่จะสามารถลดผลกระทบดังกล่าวและความเหลื่อมล้ำในค่าใช้จ่ายในการรักษาพยาบาล

Thesis Title Exploration of the hidden financial hardship of chronic kidney disease under universal coverage in Thailand

Author Ms. Pornpen Sangthawan

Major Program Health Sciences

Academic year 2022

ABSTRACT

Introduction

Chronic kidney disease (CKD) is prevalent in Thailand and has a significant economic burden to both patients and country level. The Universal Health Coverage policy in Thailand has expanded to include dialysis cost for all CKD patients since 2008 through 'PD First' policy. The 'PD First' program has often been cited as a successful model of kidney failure care for low and middle-income countries. However, Thai CKD patients still need to constantly pay out-of-pocket for health care service which may exhaust patients and family resources and result in catastrophe and poverty. The financial hardship from the patients' perspective remains unknown. This study aimed to estimate the residual financial burden of chronic kidney disease (CKD) patients under Universal Health Coverage.

Materials and Methods

This multicenter nationwide cross-sectional study was conducted in Thailand between June 2019 and January 2021. This study enrolled 1,224 CKD patients from 11 regional and university hospitals. These patients were covered by three health schemes; Universal Coverage Scheme (UCS), Social Security System (SSS), Civil Servant Monetary Benefit Scheme (CSMBS). The study population consisted of four groups of CKD patients as the followings; CKD with eGFR 15-60 ml/min/1.73m^2 (CKD15-60), CKD with eGFR <15 ml/min/1.73m^2 (CKD<15), peritoneal dialysis (PD) and hemodialysis (HD). We collected medical and non-medical out-of-pocket expenditure for healthcare service by direct patient interview. The financial burden was estimated by calculation the proportion of patients with catastrophic health expenditure (CHE) and medical impoverishment. The financial burden was compared

among CKD groups, health schemes and quintiles of socioeconomic status. The multivariable logistic regression model was used to assess the factors associated with catastrophic health expenditure.

Result

The study participants included 435 (35.5%) CKD15-60, 213 (17.5%) CKD<15, 257 (21%) PD and 319 (26%) HD, with mean (SD) age was 63.8 (14.3) years and 44% female. The percentage of patients under UCS, SSS and CSMBS were 44.1, 8.9 and 47%, respectively. Hypertension was the most common comorbidity, followed by dyslipidemia, diabetes and cardiovascular disease. Under UCS and CSMBS, HD patients suffered from CHE and medical impoverishment the most, especially among the poorest. Travel cost was the main driver of CHE in HD in all health care schemes. The adjusted probability of CHE under UCS was higher in HD than PD (53% vs. 22%, $p < 0.05$). The other associated factors with CHE were age (adjusted OR = 1.027, 95%CI: 1.013-1.019), cardiovascular disease (adjusted OR = 1.767, 95% CI:1.147-1.829) and household size (adjusted OR =0.806, 95 %CI: 0.718-0.863). CKD patients from the Central region suffered from CHE the most.

Conclusion

Despite universal health coverage, there was substantial financial hardship in CKD patients, increasing from pre-dialysis to dialysis. HD patients under UCS suffer CHE and medical impoverishment the most, despite the fact that they need to use it. This is the area that policy makers should consider strategies to minimize any CHE and potentially inequitable effect of this on their financial status.

ACKNOWLEDGEMENT

I would like to express my gratitude to the following people:

To the thesis examining committees, Asst.Prof. Dr. Vijj Kasemsup, Assoc. Prof. Paramee Thongsuksai, Dr. Pasuree Sangsupawanich, Dr. Pimwara Tanvejsilp, Professor Chagriya Kitiyakara, and Professor Nathorn Chaiyakunapruk for their valuable comments and suggestions.

To my advisor and co-advisors, Dr. Pasuree Sangsupawanich Dr. Pimwara Tanvejsilp, Professor Chagriya Kitiyakara, and Professor Nathorn Chaiyakunapruk for their valuable guidance, comments, and continuous support throughout my research.

To HSRI for funding : Prof. Piyamitr Sritara (HSRI grant ID 57-108), Prof. Chagriya Kitiyakara (HSRI grant ID 60-078)

To Dr.Sarayut Lucien Geater for patiently and kindly teaching me the basic statistical analysis and all technical support.

To Ms. Pinkaew Klyprayong, Ms. Paveena Nanphan, who provided their great support to this research.

To all study investigators: Pinkaew Klyprayong, Sarayut L. Geater, Pimwara Tanvejsilp, Sirirat Anutrakulchai, Sarinya Boongird, Pongsathorn Gojaseni, Charan Kuhiran, Pichet Lorvinitnun, Kajohnsak Noppakun, Watanyu Parapiboon, Supinda Sirilak, Pluemjit Tankee, Puntapong Taruangsri, Pasuree Sangsupawanich, Piyamitr Sritara, Nathorn Chaiyakunapruk, Chagriya Kitiyakara

To all study coordinators for assistance with patient enrollment: Songklanagarind Hospital, Paveena Nanphan; Bhumibol Adulyadej Hospital, Rattinan Singprasert; Chiang Mai University, Orapan Pankum; Nakornping Hospital, Kittiya Sattaya; Naresuan University, Parttarawee Damee; Maharat Nakhon Ratchasima Hospital, Sumalee Klungklang; Somdej Phranangchao Siririkit, Thidaratn Phetchai; Srinagarind Hospital, Buppa Tongdeenok;

Sunprasitthiprasong Hospital, Nongnuch Kuankote; Vachiraphuket Hospital, Renu Wonggerdprayot

To all study participants and caregivers who provided their valuable information so we can truly understand the financial burden among CKD patients.

To secretary and my classmates at Health science PhD program, Faculty of Medicine, Prince of Songkla University for all your support.

To nephrology unit, Department of Medicine, Faculty of Medicine, Prince of Songkla University.

Finally, to my dad, mom and family who have given me unlimited support, courage, and love.

Pornpen Sangthawan

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LIST OF ABBREVIATIONS AND SYMBOLS

CKD	=	Chronic kidney disease
ESKD	=	End Stage Kidney Disease
KRT	=	kidney replacement therapy
CKD15-60	=	Chronic kidney disease with eGFR 15-60 ml/min/1.73m^2
CKD<15	=	Chronic kidney disease with eGFR <15 ml/min/1.73m^2
PD	=	peritoneal dialysis
HD	=	hemodialysis
KT	=	kidney transplantation
UCS	=	Universal Coverage Scheme
CSMBS	=	Civil Service Monetary Beneficial System
SSS	=	Social Security Schemes
CHE	=	Catastrophic Health Expenditure
WHO	=	World Health Organization
NCD	=	Non-communicable disease
UHC	=	Universal Health Coverage
NHSO	=	National Health Security Office

Chapter 1
Introduction

1.1 Background and rationale

The prevalence of chronic kidney disease (CKD) is increasing globally and has become one of the significant non-communicable diseases that impact the healthcare system worldwide. [1-4] The prevalence of CKD worldwide was 13.4%. The magnitude of CKD is more prominent in the low-and middle-income countries than the high-income countries. The prevalence in low- and middle-income countries was 15% greater than in high-income countries, and among the high-risk population, the reported prevalence of CKD was as high as 36.1%.[5] Thailand is also a middle-income country that has been affected by the burden of CKD. From the Thai SEEK study in 2010, the overall prevalence of CKD in Thailand was about 17.6%.[6] The study by Thammatacharee N et al. reported that the number of new end-stage kidney disease (ESKD) patients in Thailand increased from 2008 to 2016.[7] The increase in the number of ESKD patients is the result of population aging and the increase in the prevalence of patients with diabetes and hypertension.[8] Furthermore, the number of ESKD patients needing kidney replacement therapy (KRT) in 2030 is projected to more than double to 5.439 million, with the most rapid growth in Asia.[5,9] Treatment of chronic kidney disease is also associated with the high cost of care and is considered the leading cause of global financial burden. The economic impact of CKD is seen in both low-income and high-income countries. Therefore, it is challenging to set up developmental goals which are sustained and impacted on decreasing the kidney disease risk, early CKD detection, and subsequently reducing the expensive care especially cost for KRT.[10]

Chronic kidney disease (CKD) is the progressive reduction of renal function for more than three months, and it is a significant risk factor for ESKD, cardiovascular disease, and premature death. According to KDIQO 2012 guidelines, CKD is categorized into five stages by levels of estimated Glomerular Filtration Rate (eGFR), as shown in Table 1.1.[11]

Table 1.1 GFR categories in CKD. [11]

GFR category	eGFR (ml/min/1.73m^2)	terms
G1	≥90	Normal or high
G2	60-89	Mildly decreased
G3a	45-59	Mildly to moderately decreased
G3b	30-44	Moderately to severely decreased
G4	15-29	Severely decreased
G5	<15	Kidney failure

The natural history of CKD is a progressive disease, with a progressive decline in renal function or eGFR until reaching CKD stage 5 or ESKD, which is the stage when patients need KRT: hemodialysis (HD), peritoneal dialysis (PD) or kidney transplantation to maintain life.[12]

The care management plans for CKD patients differ according to the stages of CKD. In the early stage of CKD, the primary purpose is to detect and correct the potentially reversible causes of impaired renal function. Management in the later stage of CKD focuses on delaying the progression of CKD and preventing or alleviating concomitant diseases (diabetes, hypertension, dyslipidemia, and cardiovascular disease). Finally, at the end stage of CKD or ESKD, management will be focused on KRT. [12,13] The different management plans for each stage of CKD affect the treatment expense and economic burden.

The retrospective study by Vupputri S et al. of 25,576 members at Kaiser Permanente found that rapid worsening in renal function was one of the significant determinants of financial burden in CKD. From this study, among type 2 diabetic patients with progression of CKD from stage 0-2, stage 3, and stage 4 CKD compared to those who did not progress, the average incremental adjusted cost was 4,569, 12,617, and 33,162 US dollars per patient per year, respectively.[14]

The systematic review by Elshahat S et al which studied the impact of CKD on developed countries, showed that from the health system perspective, the progression from CKD stage 1-2 to stage 3a-3b was associated with a 1.1-1.7 folds increase in per-patient mean annual health care cost. And the progression from CKD stage 3 to stage 4-5 was associated

with a 1.3-4.2 folds increase in cost, with the highest among ESKD patients at 20,110-100,593 USD per patient.[15]

Even though the economic burden was shown to be higher among ESKD than non-dialysis patients.[16] The direct medical cost for non-dialysis CKD was also expensive due to its high prevalence and many concomitant comorbidities.[17,18] Furthermore, non-dialysis CKD patients also need complex medical care requiring a multidisciplinary team, including primary physicians, nephrologists, nurses, dietitians, and pharmacists. These reasons contribute to the high financial burden among non-dialysis CKD.[19]

In addition, the financial burden of CKD treatment is the consequence of the direct non-medical and indirect costs. The direct non-medical costs for CKD include transportation, food, house renovation, and caregiver costs. The indirect costs for productivity loss or loss of income from absenteeism usually incur significantly at the late stages of CKD. The indirect costs are also high among elderly CKD patients because patients will become more dependent and need more care from families, friends, or formal caregiver.[20]

Millions of ESKD patients worldwide need KRT as a life-saving treatment. However, the proportion of these patients who receive KRT is relatively small. Only 2-5% of patients in low and middle-income countries can get access to kidney replacement therapy.[9] High dialysis costs are the main obstacle to getting access to KRT. Furthermore, CKD patients in many countries have to pay out of pocket for CKD care by themselves because the treatment, especially dialysis, is not covered by government funds. The natural history of CKD is a chronic, progressive disease. For patients and families with limited household resources, this constant out-of-pocket (OOP) spending for health care can exhaust patients and families and result in catastrophe and poverty.[21,22] The OOP expenditures for health care can also affect the ability of patients and families to maintain other essential living expenses. Moreover, this spending could compromise adherence to medical care and quality of life. The study by Dodd R et al. confirmed that OOP spending adversely affected adherence to CKD medications and dialysis treatment. It is also evident that poor CKD patients suffer from late diagnosis, under-dialysis, and high mortality rates.[23] OOP expense was demonstrated as one of the significant determinants of catastrophic health expenditure (CHE).[24]

The incidence of CHE and medical impoverishment reflects the magnitude of the financial burden. The study from Korea reported that 62.1% and 21.5% of ESKD patients

suffered from CHE and impoverishment. Among households with under median household income decile, the prevalence of CHE and medical poor was 92.2% and 34.4%, respectively.[25]

The study by Acquah I et al. reported financial hardship among nonelderly CKD patients in the US. The economic problem in this study is defined based on medical bills and consequences of financial hardship (high financial distress, food insecurity, cost-related medication nonadherence, delayed/forgone care due to cost). 46.9% of patients reported experiencing financial hardship from medical bills, and 20.9% were unable to pay medical bills. The most vital determinant of economic hardship was lack of insurance (odds ratio 4.06, (95% CI 2.18-7.56)). [26]

One conception of fairness or equity in health finance is to protect households from catastrophic medical expenses.[27] An equitable health financing system needs effective protection strategies to enhance patients' access to essential health care while reducing the reliance on OOP spending and increasing the risk-pooling and pre-payment mechanism.[28] The risk pooling mechanism is considered one of the robust mechanisms to protect against CHE and impoverishment.[29] Many developed countries have implemented health protection policies to subsidize a significant part of healthcare costs to prevent or alleviate catastrophe and poverty from healthcare service use. However, the financial catastrophe and impoverishment in those countries due to OOP expenditure for health care remain. For example, the data from Australia by Essue BM et al. still found a significant impact of OOP expenditures on CKD treatment. Despite the Australian health and social welfare system providing a comprehensive social health insurance system that is subsidized for most of both outpatient and inpatient services. From this study, CKD stage III-V patients needed to pay out-of-pocket with a mean of AUD$907 per three months, resulting in 71% of patients experiencing financial catastrophe.[30]

Before the implementation of universal health coverage, Thai patients had to pay 25-70% of their household income for dialysis.[31] Therefore, only a small number of ESKD patients could access KRT. In 2001, the Thai government implemented a universal healthcare security system to cover all population groups to provide a safety net for all, including the poor.[32] Thailand Universal Health Coverage consists of three major health schemes: Social Security Schemes (SSS), Civil Service Monetary Beneficial System (CSMBS), and Universal Coverage Scheme (UCS). These three schemes provide health coverage for 96.4% of the population.[33] The CSMBS provides comprehensive health benefits to government employees and their dependents. The SSS provides comprehensive health benefits for formal-sector

employees through capitation. The UCS includes health benefits for the rest of the Thai population by contract capitation for outpatient care and global budgets with diagnosis-related groups (DRGs) for inpatient care.[33]

The KRT cost had been included only in the CSMBS and SSS package schemes. ESKD patients under UCS had to self-pay for KRT costs. In 2008, Thailand's PD First policy introduced free dialysis for patients under UCS to decrease the disparity among CKD patients, especially in the low-income group. Since then, the number of CKD patients receiving dialysis has increased due to the successful PD first policy. The prevalence of patients on KRT in Thailand increased from 21,839 in 2007 to 164,191 in 2020, and the number of PD patients increased from 5.5% to 21% of dialysis patients.[7,34,35]

PD First policy has provided free dialysis for the population under UCS through fixed fees and medicines and supplies through central supply and bulk purchasing. Under this policy, patients can reimburse only when commencing PD as the first dialysis modality unless having contraindications for PD. In addition, ESKD patients who bypass PD without approval from National Health Security Office will need to self-pay for all dialysis costs.

Additionally, there is a specific extra payment for medical treatments, such as some medications (e.g., erythropoietin if patients need extra doses) or treatments that were not included in the benefits package, such as out-of-hospital medications, nutritional supplements, and traditional medicine.[36] The other health care costs that need to pay out of their pocket include medically related costs for food, transportation and accommodation, formal caregiver or home assistance, illness-related home modification (such as for dialysis set-up), or health equipment. Regarding KRT, different dialysis modalities may affect the financial burden differently. For example, patients on PD can manage dialysis at home without traveling costs, unlike HD, which requires patients to travel to a dialysis center for about 2-3 sessions per week. Therefore, PD patients can theoretically pay less OOP payments in direct non-medical costs (transportation, food, and informal care). As a result, they may suffer less CHE and medical impoverishment than HD patients. In addition, Thailand's three health benefits packages have different details in reimbursement for CKD and dialysis treatment. These reasons could also potentially cause a disparity in CKD treatment among patients under these three health schemes.

Thailand's universal health coverage effectively protects the majority of Thai households, particularly those of lower income, from CHE and impoverishment. [32,37,38] A

study by Somkotra T et al. demonstrated the significant reduction of CHE from 2000 (before the implementation of universal coverage) through 2006, especially among the poor. And the percentage of OOP payments of total household health expenditure was reduced from 34 in 2000 to 12 in 2014. The prevalence of health-impoverished households decreased by 37.4%.[33] However, certain Thai still experience CHE and impoverishment due to using services not covered by the UCS benefit package, services from private facilities, or bypassing the designated providers without proper referrals. [37,38]

Thailand's Universal Health Coverage, particularly with PD First policy, can decrease the financial burden of direct medical costs for CKD patients. However, there are certain expenses that CKD patients and families still need to pay OOP, including direct non-medical costs. These OOP expenditures may account for only a small proportion of the total costs of CKD care compared to medications and treatment costs. Still, they could potentially incur significant catastrophic consequences to patients and families, especially the poor. How this OOP spending affects the financial status of Thai CKD patients is still unknown.

The information regarding the residual financial burden among CKD patients, especially patients on KRT under these three different health schemes in Thailand, is still lacking. Therefore, the results of this study would benefit the policy maker and nephrologists to understand better the current status of the economic burden of CKD treatment in Thailand. Such knowledge will also help plan the distribution of budget and healthcare facilities to protect patients and families from catastrophe and improve the quality of CKD care. Also, it would benefit other developing countries to consider including KRT in their health security system for their CKD patients.

1.2 Research questions

1. What are the financial burden of CKD and dialysis treatment under Thailand's Universal Health Coverage and PD First policy?
2. What is the proportion of CHE and medical impoverishment incurred from CKD?
3. What are the determinants or drivers of CHE among different stages and treatments of CKD?
4. How do different health insurance schemes affect the financial burden in other groups of CKD and socioeconomic status?

1.3 Objectives of the study

Primary objective

- to compare the proportion of catastrophic health expenditure (CHE) and medical impoverishment among different CKD stages, dialysis modalities, and health insurance schemes.

Secondary objective

- to study the determinants of CHE in CKD patients.

1.4 Literature review

1.4.1 economic burden of chronic kidney disease

1.4.1.1 CKD and poverty

CKD and ESKD not only limit patients' life expectancy due to premature cardiovascular death but also significantly affect the quality of life, work capacity, and financial impact on individuals, households, and society. At the same time, socioeconomic status can also increase the risk of the development and progression of CKD.[39] Among the cohort of CKD in the Chronic Renal Insufficiency Cohort (CRIC) study, the prevalence of CKD (eGFR less than 30 ml/min/1.73m^2) was 37% in patients with income less than 25,000 USD while only 6% in patients with income more than 100,000 USD.[40]

The interaction between poverty and CKD has been documented. Poverty related to poor health outcomes: cardiovascular disease, hypertension, obesity, diabetes, and death. Low socioeconomic status affects healthcare access, environmental exposure, and health behavior which are significant determinants of health outcomes.[41]

Chronic toxic stress, induced by poverty, adversely affects the hypothalamic-pituitary-adrenocortical axis, leading to dysregulation of cortisol production and increase inflammation. In addition, poor access to healthy food leads to malnutrition, especially in early life, which has subsequently been related to chronic illnesses such as diabetes, hyperlipidemia, and cardiovascular disease.[42]

The proposed pathways demonstrate the effect of socioeconomic status on CKD and its outcomes, as shown in Figure 1.1.

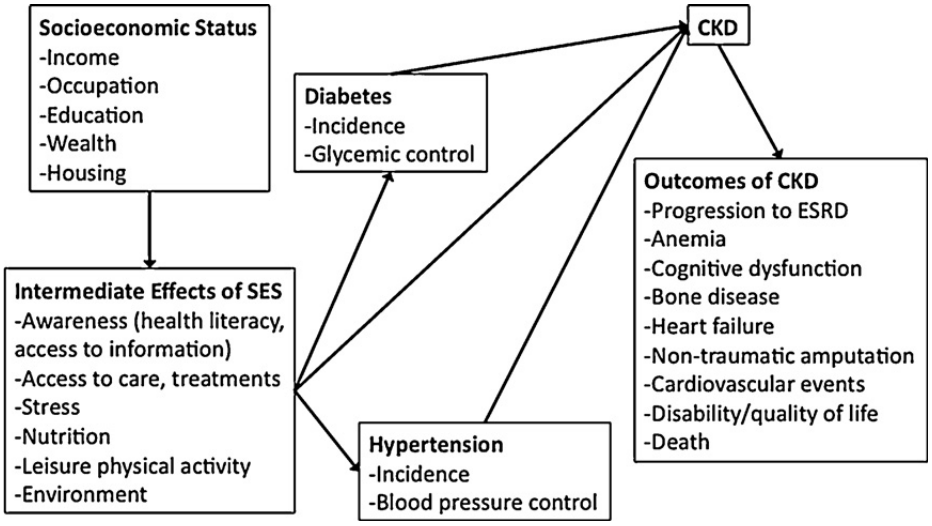

Figure 1.1 proposed pathways showing the effect of socioeconomic status on CKD and outcome. [39]

Low socioeconomic status was shown to be associated with a high risk of rapid progression of CKD and mortality.[43,44]

A study by Krop JS et al. showed that diabetic patients with income lower than 16,000 US dollars were associated with a greater risk of kidney function decline than patients with income greater than 35,000 US dollars.[45]

Another study analyzed data from 14 countries and demonstrated that a higher stage of CKD increased the risk of developing poverty. When compared with CKD stage 3, the risk of becoming poor was OR 1.51 (95% CI 1.09-2.10) for CKD stage 4, OR 1.66 (95% CI 1.11-2.47) for CKD stage 5, and 1.78 (95% CI 1.22-2.60) for dialysis patients. The risk of developing poverty in kidney transplant patients is about half of the risk of CKD stage 3-5 patients.[46]

A meta-analysis study by Zeng X et al. found that CKD prevalence was associated with several indicators of socioeconomic status (SES), notably lower income (OR 1.34, 95% CI 1.18-1.53), lower education (OR 1.21, 95% CI 1.11-1.32) and lower combined SES (OR 2.18, 95% CI 1.64-2.89). Lower income, occupation and combined SES were also significantly associated with progression to ESKD.[47]

1.4.1.2 Cost of CKD care

The economic burden of CKD is enormous and has become a primary public concern worldwide. Chronicity, progressive natural course, and high prevalence of concomitant comorbidities make CKD treatment expensive. Healthcare costs for CKD include the cost of screening for impaired kidney function and delayed progression of CKD, as well as management of comorbidities (e. g. , diabetes, congestive heart failure, stroke, and hypertension) and dialysis.

The study by Laliberte F et al. analyzed the medical claims on managing patients with diabetes and hypertension between 2000 and 2006. Diabetes and hypertension were the leading causes of CKD and ESKD in this study. This study showed that CKD contributed to significantly higher total direct costs among patients with diabetes and hypertension. The mean (median) total direct costs were diabetes vs. diabetes with CKD 6,631 (4,131) vs. 18,444(11,025), p<0. 001, hypertension vs. hypertension with CKD 6,226 (3,703) vs. 14,638 (7,817) , p<0. 001, diabetes and hypertension vs. diabetes and hypertension with CKD 10,827(6,637) vs. 21,452(13,840), p < 0.001.[48]

The US study by Smith DH et al. reported that CKD patients spent 1.9-2.5 times more medication prescriptions, 1.3-1.9 times more outpatient visits, and 1.6-2.2 times more inpatient stays than age- and gender-matched control. Cost of CKD care per patient increased according to stages of CKD: CKD stage 2 USD 38,764 (95% CI 37,033-40,496), CKD stage 3 33,144 (95% CI 32,578-33,709), stage 4 41,928 (95% CI 39,354-44,501).[49]

The costs which contribute to the economic burden of CKD are summarized as shown in figure 1.2.[50]

1. direct costs consist of the expense for all medications, services, and other resources spent to provide treatment, interventions, or treatment of side effects as well as the consequences of illness.

Direct costs can be divided into

1. direct medical costs: medications, diagnostic tests, vaccines, and hospitalization. These direct medical costs include treatment outside the hospital, during hospital admission, self-bought medications from the drugstore, nutritional supplements, and alternative medicines.

2. direct non-medical costs: costs of transportation, food, costs of child care, house renovation, exercise program, and formal caregiver.

2. indirect costs reflect patients' productivity loss due to illness or death. Among CKD and ESKD patients, despite the aggressive treatment, patients still become more disabled and fragile and have productivity loss as the disease progresses.[50] The indirect cost potentially increases towards the end stage of the disease.

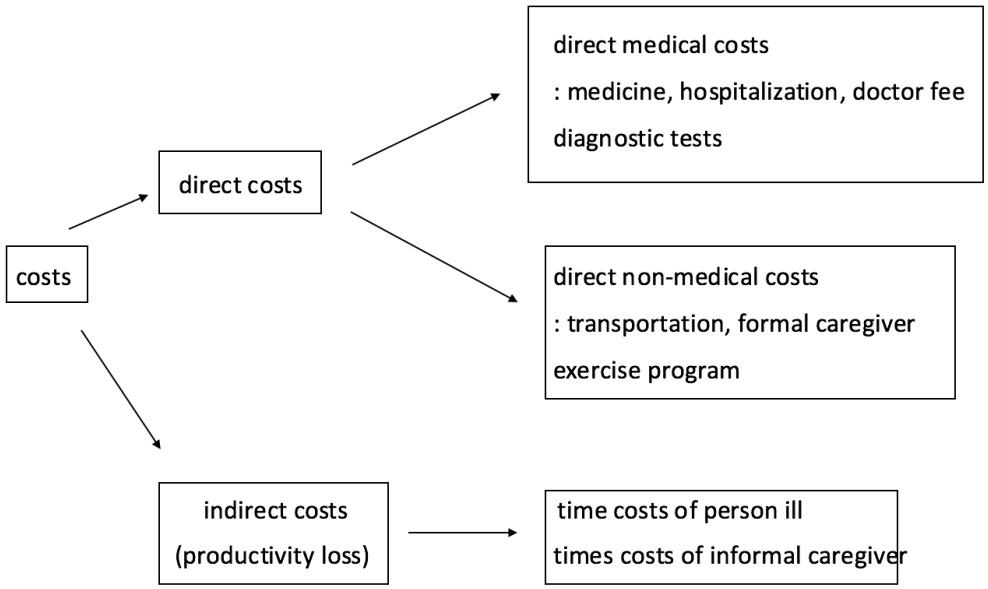

Figure 1.2 direct and indirect costs. [50]

Factors that determine the costs of the disease are the incidence and prevalence of the disease and the use of costly treatments. The detailed and magnitude of direct and indirect costs of different stages of CKD varied according to care management strategies, as shown in Table 1.2. The costs for treatment of ESKD patients were higher than non-ESKD patients for direct expenses (KRT costs, treatment of comorbidities) and indirect costs (productivity loss, premature death). [51,52]

Table 1.2 Direct and indirect costs and expected magnitude by stage of CKD. [50]

	CKD Stage					
Description of Costs	1	2	3	4	5	ESRD
Direct costs						
Medical						
Diagnostic screening, imaging	●	●	●	●	●	•
Physician office visits	●	●	●	●	●	●
Laboratory tests	●	●	●	●	●	●
Medication	●	●	●	●	●	●
Vaccines	●	●	●	●	●	●
Hospitalization	•	•	•	●	●	●
Predialysis surgery (access placement)					●	●
Dialysis					●	●
Transplantation					●	●
Nonmedical						
Transportation	•	•	•	•	●	●
Informal caregiving	•	•	•	●	●	●
Indirect costs						
Presenteeism (eg, reduced work performance)	•	•	•	●	●	●
Absenteeism (eg, work missed, sick days)			•	•	•	●
Productivity loss as a result of disability			•	•	●	●
Productivity loss as a result of premature death	●	●	●	●	•	•

Costs by stages of CKD [50]

1. costs of CKD stages 1 and 2

CKD patients at these early stages are primarily asymptomatic. The concomitant illnesses such as diabetes, hypertension, and cardiovascular disease are the main determinants of patients' health status, morbidities, hospitalization, and mortality. The expense for comorbidities is the main contributor to the direct costs in these stages of CKD, as shown in Table 1.3.

2. costs of CKD stage 3

At this stage of CKD, hospitalization and mortality rates increase compared to the earlier stages. Therefore, the cost of health care is higher than for patients with stages 1-2, especially those with diabetes and cardiovascular disease, as shown in Table 1.3.

Another contributor to health care costs for CKD stage 3 is the cost of the progression of CKD. A retrospective cohort study of 25,576 members at Kaiser Permanente by Vupputuri S et al. showed that the average incremental adjusted costs among type2 diabetic patients with progression of CKD from stage 0 - 2, stage 3, and stage 4 CKD were 4,569, 12,617, 33,162 USD per patient per year which were higher than those who did not progress.[14] Therefore, the intervention to delay the progression of CKD could potentially decrease the financial burden.

3. costs of CKD stage 4 and stage 5 (nondialysis-dependent)

CKD patients at these late stages experience high comorbidities, hospitalizations, and death rates. Furthermore, these patients tend to become more dependent and need more support from families, friends, or formal caregivers. These reasons cause more direct medical costs for medications, hospitalizations, non-medical costs for transportation and caregivers, and indirect costs for loss of income from sick leave.[20]

The US study demonstrated that compared to CKD stage 1, the incremental total annual healthcare expenditures were stage 3A, USD 1,732; stage 3B, USD 2,632; and stage 4, USD 6,949. The results emphasized the significant increase in economic burden as renal function declined.[53]

At stage 5 but before dialysis commencement, there will also be an extra cost for preparation for KRT, either dialysis or kidney transplantation.[50] For ESKD patients planned for HD, there will be a cost for vascular access formation. For PD patients, there will be a cost for Tenckhoff catheter insertion. If CKD patients need urgent or unplanned HD, there will be an extra cost for temporary catheters and urgent dialysis.

4. costs of ESKD

Table 1.3 shows that treating ESKD patients costs nearly double the therapy of non-ESKD patients. The cost for HD was the highest, followed by PD and KT.[50]

Table 1.3 Direct medical costs by stage of CKD, data from US Renal Data system 2014 and 2015 (costs in US dollars).[50]

	All stages	Stage 1-2	Stage 3	Stages 4-5	ESKD
overall	20,162	17,969	19,392	25,623	65,142
CKD and DM	22,723	20,247	22,007	29,378	Not available
CKD and congestive heart failure	31,648	30,850	31,301	37,295	Not available

The cost spending on CKD treatment from USRDS 2019 reporting on the annual Medicare was more than $ 120 billion in 2017, with increasing costs associated with advancing CKD severity.[54] Saran R et al. studied the cost of CKD care among US Veterans and found

that CKD stage 3 spent the most among non-dialysis CKD. Advanced CKD stage and comorbidities were the drivers for higher costs.[55]

From the Study of Heart and Renal Protection (SHARP) randomized trial on 7,246 moderate to severe CKD patients from Europe, North America, and Australasia, CKD patients without diabetes or vascular disease incurred annual hospital costs were 403 (95% CI 345-462) dollars in CKD stage 1-3b and 525 (95% CI 449-602) dollars in CKD stage 5 (not on dialysis). The average annual hospital costs for dialysis patients were 18,986 (95% CI 18,620-19,352) dollars in the first year of KRT and 23,326 (95% CI 23,231-23,421) dollars thereafter.[56]

The study from Australia demonstrated a significant increase in direct health care costs to the progression of CKD. The cost increased from $1,829 (95% CI 1740-1943) for those without CKD to $14,545 (95% CI 5,680-44,842) for those with stage 4 or 5 CKD ($P < 0.01$). There is also a significant difference in the direct non-healthcare costs by CKD status from $524 (95% CI 413-641) for those without CKD to $2,349 (95% CI 386-5156) for those with stage 4 or 5 CKD, ($P < 0.01$). Patients with CKD incurred 85% higher healthcare costs and 50% higher government subsidies than non-CKD patients.[20]

The study by Golestaneh L et al. using an electronic medical records database involving 106,050 CKD patients and 56,761 non-CKD patients found that US health plans spending increased exponentially with CKD progression, especially on ESKD costs and costs for hospitalization.[57]

The IRIDE Observational study in CKD patients found that the advanced CKD stage was one of the significant predictors of higher costs. The estimated cost for patients with CKD stage 5 was 4.7 times the cost for patients at stage 1 CKD.[19]

Manns B et al. studied the cost of care for CKD patients in Canada using the administrative health database. The costs were higher for patients with comorbidity, lower eGFR, and more severe albuminuria.[51]

The report on Dutch health care claims by Van Oosten MJM et al. was CKD patients needed higher additional care for comorbidities with corresponding extra health care costs, resulting in much exceeding those of the general population.[58]

The Japanese study by Higashiyama A et al. on 4,026 Japanese National Health Insurance beneficiaries found a negative correlation between the GFR category and means of OOP medical expenditures. The adjusted mean of medical spending was 167,879 yen for GFR $\geq$ 90 ml/min/1.73m^2, 210,660 for 60 $\leq$ GFR < 90 ml/min/1.73m^{2,} and 330,050 yen for 30 $\leq$

GFR < 60 ml/min/1.73m^2. The CKD-related medical expenditures contributed 11.5% and 6.5% of total medical spending for mild and moderate CKD patients. From this study, the prevention of mild CKD is crucial for controlling medical expenditures. [17]

Another study from Japan by Nagai K et al. reported medical costs for CKD patients. This study examined 70,627 people and found that the highest cost was among CKD patients with a rapid decline in eGFR ($\leq$ -30%/year). The main cost contributor was the initiation of dialysis in women with a rapid decline in kidney function.[59]

The study by Roggeri A et al. in Italy showed that the cost increased according to the stages of CKD. The direct costs per patient were 5,239, 12,303, and 3,8821 euros for 24-12 months pre-dialysis, 12-0 months pre-dialysis, and in the first year of dialysis, respectively. The cost for hemodialysis was 40,132 euros and for peritoneal dialysis was 30,444 euros per year.[60]

The study by Adejumo OA et al. demonstrated that the major contributors to the cost of CKD care in Southwest Nigeria were dialysis treatment, in-hospital care, and medications.[61]

Wu H et al. studied the economic burden of KRT in China and reported that the mean unit monetary expenses of PD were less than HD ($110,59.8$\pm$709.51 vs. 117,83.6$\pm$402.63, respectively).[62]

The systematic review by Mushi L et al. reported the cost of dialysis in low and middle-income countries. The annual cost per patient for HD ranged from Int$ 3,424 to 42,785, and PD ranged from Int$ 7,974 to 47,971. The main cost contributors were direct medical costs, especially drugs and consumables for HD and dialysis solutions and tubing for PD.[16]

The report from German also showed similar results that average costs per person per year increased according to the stage of CKD: Euros 8,030 (95% CI 7,848-8,212) CKD stage 3, Euros 9,760 (95% CI 9,266-10,255) CKD stage 4 and Euros 44,374 (95% CI 43,608-45,139) on dialysis. [63]

The data from Thailand by Songsermlosakul S et al. on costs for treatment among 212 CKD stage 3-4 patients from a district hospital reported that the cost for CKD stage 4 was double compared to CKD stage 3.[64]

Apart from higher direct medical costs, the direct non-medical costs also increase in advanced CKD. End-stage CKD patients become more dependent and need extra care from both formal and informal caregivers.[20,65] There were 71% of ESKD patients in the US unemployed. Toward the end stage of the disease, CKD patients become more fatigue and

experience more comorbidities or premature death, which prevent them from working or productivity. The absence from work results in an extra financial burden to patients and families.[11]

The evidence emphasized the economic burden of CKD on patients, families, and countries in both developing and developed countries. The magnitude of the burden increases according to the stage of CKD, with the highest burden from dialysis cost. But most of the data on financial burden is from the government level. The impact on the patient level has not been extensively studied.

1.4.2 Catastrophic Health Expenditure (CHE) and medical impoverishment

1.4.2.1 Definition of CHE and medical impoverishment

CHE and medical impoverishment have been used as indicators of financial burden.[66] CHE is the expenditure for health care services that can threaten a household's financial ability to maintain its subsistence need. Subsistence need means the minimum household expenditures to sustain basic necessities such as food, shelter, clothing, and education.[28] Households' capacity to pay is the effective income remaining after paying for subsistence needs. Total household consumption expenditure has been used as the surrogate of effective income because it reflects more accurately purchasing power than income reported in the household survey. Out-of-pocket spending for health care services may affect the ability to maintain necessary living expenses and compromise adherence to medical care and the quality of life. CHE incurs when OOP payment consumes a more significant proportion of household income, and the household needs to compromise the expenditure on basic needs. However, the low incidence of catastrophic expenses might reflect people getting needed care with protection from OOP cost or not getting (and not paying for) needed care.[66]

World Health Organization considers CHE when OOP payment for health care service is equal to or exceeding 40% of a household's non-subsistence income or capacity to pay. There is no consensus regarding the threshold of household expenditure to determine CHE. Studies using the alternative cut-off for the evaluation of CHE, such as the various threshold from 5-25% of total household income or expenditure.[24,66]

Medical impoverishment means the OOP payment, which pushes the household into poverty after paying for health care services. The poverty threshold can be determined by using

the poverty line recommended by WHO or household income or expenditure after the deduction of food expenditure.[66]

1.4.2.2 Financing for health care services

There are four main types of financing for health care service use.

1. government funded (through taxes)
2. social insurance (through payroll, taxes, or direct contribution)
3. private insurance
4. out-of-pocket (OOP)

In developing countries with no substantial government funding system or social insurance, OOP payment for health care service is the most important way of financing health care but inefficient, inequitable form. OOP payments accounted for 50% of total health expenditure in 33 low-income countries in 2007. OOP spending includes direct medical costs (doctor fees, medications, tests, hospital bills) and non-medical costs (transportation to health care facility, daily living cost for accompanying household members, loss of income due to sick leave).[28] The medication expenditure accounts for 18-55% of total health expenditure in many countries. This expense that patients have to pay OOP exceeds 70% of total health expenditure in Bangladesh and India.[28]

In countries that do not provide free healthcare services, self-paying for medical treatment is a common cause of financial burden to patients and families. The regular OOP payments can exhaust patients' and family resources and result in catastrophe and poverty. [21,22] The study from China reported that OOP spending for health care increased poverty by 3.96%. The other contributors to CHE and medical impoverishment are low socioeconomic status, poor health service accessibility, and lack of risk pooling (government funding or insurance).[28] The significant policies which effectively reduced medical impoverishment were providing insurance coverage and controlling medical costs. [28]

The summary of the consequences of high OOP spending for health care in figure 1.3.[21]

1. people may not seek treatment due to poor, which leads to poor health and eventually poverty.
2. exhaustion of assets.

3. borrowing and resulting in debt.

4. changing consumption patterns: cutting down the basic needs (food, education).

5. labor substitution, which can lead to productivity loss

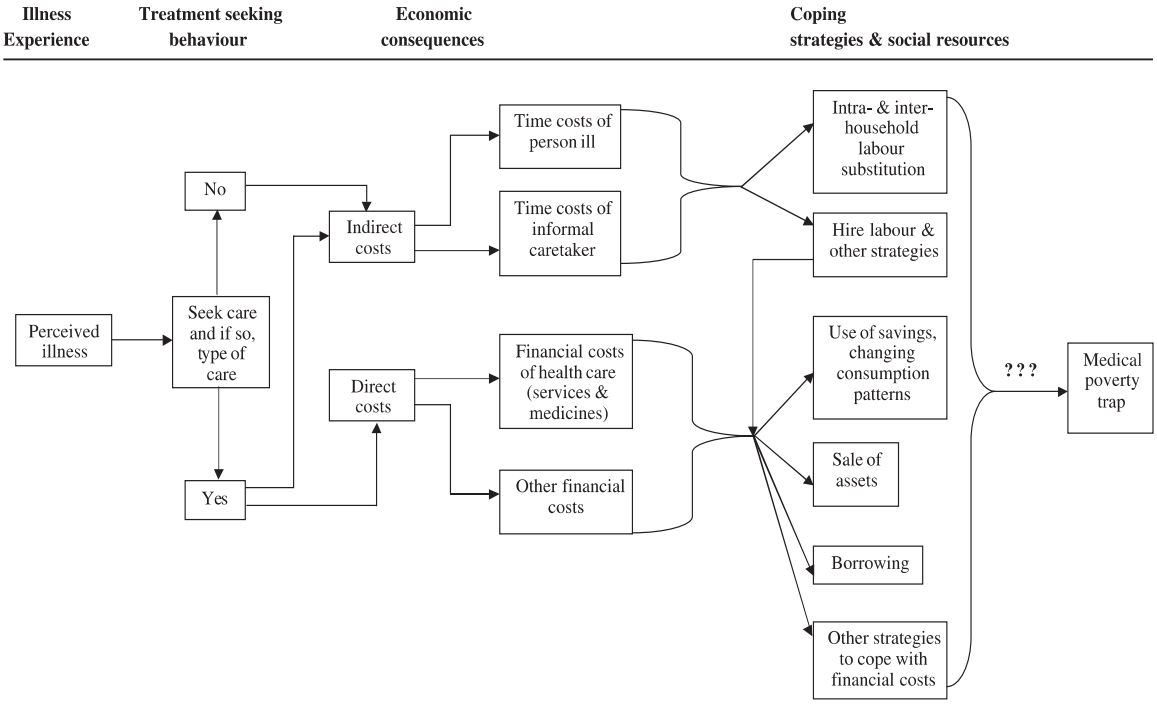

Figure 1.3 Consequences of OOP spending for health.[21]

1.4.2.3 Factors that are associated with CHE [28]

CHE may incur when patients need to rely mainly on self-pay for health services.

The factors that are related to the development of CHE are

1. living in an urban versus rural area

The studies in India, China, and Kenya showed that the proportion of CHE and poverty in patients who lived in rural is higher than in urban. The reason may be the lack of insurance coverage among rural people.[28]

2. sociodemographic factors

The patients in the low socioeconomic group who pay for expensive medical care may subsequently incur financial catastrophe.[67] Poor sociodemographic status determined by older income earners, unemployed heads of the family, a low number of working adults, and members with disabilities increases the risk of CHE. [28,68,69]

The study by Goeppel C et al., which assessed the effect of universal health coverage for adults with chronic illness in six middle-income countries, found that financial hardship was more common among the poor in most countries but incurred in all income groups. Health insurance generally increases access to health care services but does not provide enough protection against financial catastrophe.[67] So financial burden from health care use may not be protected by universal health insurance, especially among the poor.

3. type of illness

Chronic illnesses or non-communicable diseases (NCD) account for economic burdens in high-income and low-and middle-income countries.[70] Burden of NCD is more significant among the poor because of the chronic nature of the disease. Their treatment consumes money and resources over a more extended period than acute illnesses. Medicines are usually the most significant component of costs. Households also are affected by the costs associated with lost income-earning opportunities.[71] Consequently, families with NCD can easily incur catastrophic health expenditure and medical impoverishment.[72]

The study by Islam R et al. in Bangladesh found that 9% of the population experienced catastrophic payments, 7% faced financial distress, and 6% experienced medical impoverishment. The risk of impoverishment increased nearly double in households with chronic illness.[73]

The study by Somkotra T et al. on catastrophic health spending in Thailand found that households with members with chronic illness or disability and members who experienced hospitalization were at increased risk of incurring CHE. [74]

A cross- sectional survey study by Kien VD et al. in Vietnam showed that poor households were at higher risk of experiencing CHE. The poor households in slum areas were also at higher risk of the development of medical impoverishment. Having family members with NCD was significantly associated with CHE and impoverishment with OR 2.4 (95% CI 1.8-4.0) and 2.3 (95% CI 1.1-6.3), respectively.[75]

The study from China demonstrated that chronic disease was one of the determinants for a high proportion of CHE. Households with cardiovascular disease combined with > 3 other chronic disorders were at the highest risk of developing CHE.[76]

The systematic review by Rijal A et al. on the economic impact of non-communicable diseases among households in South Asia showed high OOP spending and a high likelihood of

CHE and medical impoverishment among patients with NCD in all income levels. The most common coping mechanisms were borrowing and selling off assets.[77]

The systematic review by Sum G et al. reported that multimorbidity was associated with high OOP spending for medicines. The number of comorbidities increased, and patients needed to spend a higher proportion of total household expenditure on health care. Elderly and low-income patients were the most vulnerable groups. Non-adherence to medicine was the coping strategy when patients could not afford medicines.[78]

Another systematic review by Larkin J et al. also confirmed that chronic diseases and multimorbidity increase the risk of financial burden. Financial burden also compromises the health of people with multimorbidity through non-adherence to medication and self-management practices and non-attendance at healthcare appointments, which could negatively impact treatment outcomes.[79]

4. types of healthcare facilities and providers

The study from Burkina Faso found that using private health care services is associated with a high level of OOP, and modern health care utilization is one of the determinants of CHE.[69]

The study by Somkotra T et al. in Thailand found that using private facilities and having a member who experienced hospitalization increased the likelihood of developing CHE.[33]

5. lack of risk pooling mechanism such as risk protection policy

Financial risk protection mechanisms include government funds, social insurance, and private insurance.[28] The principle of these risk protections is to ensure that the cost of care does not put people at risk of financial catastrophe.[28]

Universal coverage is one form of risk pooling mechanism. WHO defines universal coverage as the measure for patients to get access to health care use at an affordable cost to achieve equity.[29] The budget sources in the universal coverage depend on the mechanisms to collect the financial contribution. The economic contribution should be prepaid and pooled from different sources so that all share the risk of paying for health services. There are two strategies: tax-funded health financing and social health insurance. The social health insurance schemes combine sources of funds from workers, self-employed people, businesses, and the government, which contributes on behalf of people who cannot afford to pay themselves.[29] If there is no risk pooling mechanism, health care expenditure will come only from people's self-

pay, increasing the risk of CHE and medical impoverishment.[24] Alternatively, low-income families may forego that healthcare because of unaffordable costs.[80]

The study by Wagstaff et al. of the progress on catastrophic health spending in 133 countries confirmed that prepaid mechanisms through taxes and mandatory contributions negatively correlated with the incidence of catastrophic health spending.[6]

1.4.3 Financial burden from chronic kidney disease

The financial burden of CKD results from medical and nonmedical spending. One contributor to the economic burden of CKD is comorbidities. Multiple comorbidities such as diabetes, hypertension, dyslipidemia, and cardiovascular disease in CKD patients contribute to high healthcare utilization.[63] Moreover, multimorbidity is also found to be disproportionately affected by low socioeconomic patients who are vulnerable to developing financial hardship.[81]

The study by Acquah I et al. reported financial hardship among nonelderly CKD patients in the United States. This study defined financial hardship based on medical bills and consequences of financial hardship (high financial distress, food insecurity, cost-related medication nonadherence, delayed/forgone care due to cost). 46.9% (95% CI 43.7%-50.2%) of patients reported experiencing financial hardship from medical bills and 20.9% (95% CI 18.5%-23.6%) inability to pay medical bills at all. The most vital determinant of economic hardship was lack of insurance (odds ratio 4.06 (95% CI 2.18-7.56).[26]

Another main contributor to health care spending in CKD patients is dialysis cost. Dialysis is essential for ESKD to maintain life, but it is very costly. The estimated annual hemodialysis costs per patient were US$ 7,500 in China, US$ 5,000 in India, and US$ 6,420 in Indonesia. Many low- and middle-income countries do not include KRT as part of the health care benefit. Therefore, ESKD patients can incur catastrophe, and the families are driven into poverty if they self-pay for dialysis treatment. This catastrophic spending results in strictly limited or unaffordable access to dialysis or kidney transplantation in many low- and middle-income countries.[82]

In India, the prevalence of CKD and ESKD is as high as the other countries, but it is estimated that only 10-20% of ESKD patients continue long-term KRT. And the prevalence of financial distress among ESKD patients was as high as 70%.[83] The median direct cost per patient for each dialysis session was Rs.5,490 (IQR 3,950-10,934). The OOP expenditure in dialysis patients was 42.7% for transport, 22.2% for food, and 20.8% for drugs.[84] The indirect cost (opportunity loss from work) accounted for 25% of total health care cost. [85] The direct nonmedical and indirect costs were the main reasons for making HD unaffordable for the majority of the population, even if dialysis is provided for free by the government.[85]

Data from Sudan also emphasized high OOP expenditure for dialysis. Yousif AO et al. reported the median overall annual total OOP (direct medical and direct nonmedical) payments in HD patients from Sudan was US$ 3,859.1 (IQR 2,298.1-6,261.1). The median annual direct

medical and nonmedical costs were US$ 2,327.6 (IQR 1,421.5-3,804.8) and 1,096 (IQR 715.2-2,345.2), respectively. Direct medical expenditure accounted for 60% of the overall total expenses. The OOP spending was higher than the per capita GDP (US$ 3,265). The uninsured patients, comorbidity, female, and those aged > 40 years spend high OOP expenditure for health.[86]

White SL et al. in 2008 reported the disparity in the percentage of CKD patients who accessed KRT facilities. Approximately 80% of KRT patients live in Europe, Japan, or North America. Less than 10% of Indian ESKD patients received KRT, and up to 70% of those starting dialysis died or stopped treatment due to cost within the first three months.[87] One study reported similar findings that only 27% of patients who needed KRT received this treatment globally, and only 2 and 5% of CKD patients in low and lower-middle-income countries can access KRT.[88] There was the most significant gap in low-income countries, especially Asia and Africa, in access to KRT (1.97 million people needing but not receiving KRT).[9,89]

The low number of patients receiving KRT reflected the limited economic capacity of low- and middle-income countries to provide this high-cost treatment. The prevalence of dialysis patients is proportional to GDP per capita. In countries with a GDP per capital above 14,000 USD, dialysis access is more equitable and less relied on self-pay or restricted service provision.[10] Dialysis treatment in many developing countries rarely supplies by the government because of budgetary constraints and the lack of health systems such as trained personnel.[90] Furthermore, because of the high gap between government budget spending on health care and dialysis costs, maintenance dialysis is often confined to private providers. The data from South India by Suja A et al. found that only upper or upper-middle-class patients can undergo hemodialysis regularly because patients have to self-pay for dialysis costs.[85] Therefore, poverty was the main obstacle to getting access to dialysis treatment. In poor, developing countries, access to KRT depended either on health insurance or taking on a loan, selling property, pooling from family resources, or getting support from the charity.[91]

Dialysis access is one example of inequity in healthcare utilization. It is challenging to sustain kidney replacement programs and increase the number of patients accessing them in these low-middle-income countries.

Self-paying or OOP for health care service is an important cause of CHE and medical impoverishment. There are strategies to relieve the financial burden incurred by patients and families. The safety net or health care coverage is one of the potential strategies to prevent or

decrease the impacts of the financial burden from health care service utilization. The World Health Assembly in 2005 declared universal health coverage to emphasize the human right to health.[29] This Universal Health Coverage (UHC) should ensure that all people have access to needed health services of sufficient quality without suffering financial burden. This UHC should cover health promotion, prevention, treatment, and rehabilitation. The services should also be available and located close to all people.[92] There are two aspects of UHC: service coverage (everyone receives needed health care) and financial protection (patients and families do not suffer financial hardship).[66]

Following the Universal Health Coverage concept, many countries have started health protection programs, such as free dialysis access. Malaysia, Taiwan, and United Kingdom offer dialysis choices for HD or PD. ESKD patients in these countries can choose dialysis modalities, and HD is the most frequent. Hong Kong has implemented a policy on PD as the first-line treatment. Compared with HD, PD has a relatively lower cost for providers (including capital investment), less healthcare provider staff needed, and lower travel time and cost for patients, leading to increased patient autonomy and satisfaction.[93]

Even though many countries have set up universal coverage programs for CKD and dialysis treatment, there is still hidden cost incurred to patients and families, which do not include in the benefits package, such as traveling to health care services and the loss of wages for patients and caregivers.[94]

The data from Australia by Essue BM et al. still found a significant impact of OOP expenditures in CKD stage III-V patients that they have to self-pay a mean of AUD$ 907 per three months. 71% of patients experienced financial catastrophe despite the Australian health and social welfare system providing a comprehensive social health insurance system that subsidizes most outpatient and inpatient services.[30]

Shin SM et al. found the remaining financial burden among ESKD patients under Korea's health security system (National Health Insurance and Medical Aid). There were 305 ESKD patients enrolled in the study. OOP spending for admission and outpatient visits by the National Health Insurance was 2.6 and 3.1 times higher than Medical Aid. The prevalence of CHE and medical poor was 62.1% and 21.5% among patients under National Health Insurance and 58.5% and 16.2% among those under Medical Aid. For patients under National Health Insurance with less than the median of the total household income decile, the prevalence of CHE and medical poor was 92.2% and 34.4%, respectively.[25]

In 2005, the Indonesian government started Financially Unfavorable Family Health Insurance to cover unprivileged people. All costs for HD and CAPD with three fluid exchanges cover by government health insurance. PD, with four fluid exchanges, covers 80% of total costs. In Indonesia, the financial burden for ESKD treatment increased from $5,776,565 in 2002 to $7,691,046 in 2006. Dialysis treatment remains unavailable for a large proportion of the population. There were only 15.5% of patients had access to kidney dialysis services.[95]

In the Philippines, the government partially covers the HD costs. PhilHealth supported funding for HD but at a different level of coverage. Therefore, poor HD patients were forced to take suboptimal HD sessions, lowering their quality of life and limiting their life expectancy.[96]

1.4.4 Thailand's Universal Health Coverage and effect on the financial burden

WHO has recommended the Universal health coverage system as the effective mechanism to prevent CHE and impoverishment. The health care service or treatment should be equitably accessible across all income levels, whenever needed, and at an affordable price.[27] Thailand is among many countries that have been working toward health for all and improving equity in access to healthcare. After the economic crisis, there were more poor people, which widened the inequity gap in Thailand.[37] Before 2001, Thailand's health care service schemes consisted of Social Security Schemes (SSS), Civil Service Monetary Beneficial System (CSMBS), Medical Welfare Scheme, and the Voluntary Health Card Scheme. There were specific numbers of poor people uninsured.[97,98] In 2001, the Thai government implemented the 'Universal Coverage Scheme (UCS)' with full coverage nationwide in April 2002.[33] The universal health care system in Thailand consisted of three primary health schemes: Universal Coverage Scheme (UCS), Social Security Schemes (SSS) and Civil Service Monetary Beneficial System (CSMBS). These primary health schemes provide health coverage for 98.5% of the population by 2015.[99]

The benefit of three of Thailand's major healthcare schemes [99]

1. Civil Servant Medical Benefit Scheme (CSMBS) provides health benefits to government employees, and their dependents, through fee-for-service reimbursement for provider payments.

2. Social Security Scheme (SSS) is contributed by the government, employer, and employee. This scheme provides health benefits for formal- sector employees through capitations.

3. Universal Coverage Scheme (UCS) covered the rest of the population. The UCS's financing source is a general tax, the most progressive financing source.[5] This scheme employs contract capitation for outpatient care and global budgets with diagnosis-related groups (DRG) for inpatient care.

The objectives of the national health financing systems are to facilitate access to health services when needed, protect a household from financial catastrophe through the development of risk pooling and prepayment mechanisms, and reduce reliance on self-payments.[100] Since the implementation of Thailand UCS, healthcare services use have increased accordingly. The rate of ambulatory care in 2003 was about 20.1% higher than before UCS.[37]

The UCS provides comprehensive health services in both breadth and depth of coverage. It includes outpatient services, inpatient services, high-cost care, disease prevention, and health promotion. The UCS operates through a capitation contract model. UCS members must register with a primary care unit to be entitled to free health services. The designated provider is the district health system, including the district hospital and its affiliated health care centers. If patients require special investigations, treatments, or care beyond the capacity of local health services, there will be a systematic referral to provincial or specialized hospitals. Suppose the patients bypass the primary care or district hospital level or use services outside the registered providers without a referral. In that case, patients will need to pay for the entire cost of treatment.[37,99,100,101]

The physical or geographical barriers could be one reason for the lack of universal health care in reducing the financial burden among the poor. Therefore, UCS contracts the district health providers to provide services for local patients to ensure efficient health services use and proper referral systems. The health care cost provided by primary care providers in the district health system is much lower than provincial hospital-based services. The households' OOP expense for transport is also much lower. When the majority of UCS who are poor can access services provided by the local network, this results in equity in health utilization and a pro-poor public policy on health. This measure through the district health system is one mechanism to demonstrate the achievement of health equity in Thailand.[102] After implementing the universal coverage policy, the success of the Thai universal coverage policy

in a major reduction of health care costs and protected the majority of Thai households, particularly those with lower income, from incurring financial hardship reported.[33,74,99]

The financial catastrophe and impoverishment due to healthcare costs have declined since the introduction of UCS. The study by Limwattananon S et al. in 2007 found that the incidence of CHE and medical impoverishment decreased after the introduction of UCS. The incidence of CHE was reduced from 5.4% pre-UCS to 3% after the introduction of UCS. Out-of-pocket expenditure for health care decreased from 18.3% to 8-10% after UCS. The major causes of residual catastrophic spending and impoverishment were the use of services not covered by the UC benefit package and bypassing the designated providers.[38]

The household OOP payment for health after the introduction of UCS reduced from 34% in 2000 to 27.6% in 2005. Before UCS, the incidence of CHE, defined as a level of OOP payment for health, exceeded 10% of total household consumption expenditure was about 4.7%, ranging from 7.1% in the wealthiest quintile to 2.7% in the poorest quintile. The incidence of CHE among UCS beneficiaries was 3.2% in 2002, 2.6% in 2004, and 1.9% in 2006. As a result of UCS coverage, the poorest quintile benefited most in preventing health financial catastrophe. The incidence of CHE among the poor was 1.7% in 2002, 1.6% in 2004, and 0.9% in 2006, respectively. The incidence of CHE in the wealthiest quintile also decreased from 6.1% in 2002 to 3% in 2006. However, the incidence among the rich was still higher than among the poor because of bypassing the registered providers and using private hospitals.[102]

Somkotra T et al. studied the impact of the universal coverage policy implementation on the incidence of CHE.[33] Table 1.4 demonstrates the significant reduction of CHE from 2000 (before the implementation of universal coverage) through 2006, especially among the poor.[33]

Table 1.4 The incidence of CHE (by two methods) comparing from 2000 (before the implementation of universal coverage) through 2006. [33]

Survey/Threshold	quintile of socioeconomic status					
	1(poorest)	2	3	4	5(richest)	Total
SES 2000						
-10%of total consumption	5.6	5.9	5.86	6.51	8.35	6.44
-40%of household capacity to pay	0.93	0.71	1.13	1.29	2.1	1.23
SES 2002						
-10%of total consumption	2.75	4.13	4.38	5.85	8.02	5.03

-40%of household capacity to pay	0.52	0.86	0.93	1.12	1.93	1.07
SES 2004						
-10%of total consumption	3.04	3.83	4.45	5.19	7.81	4.86
-40%of household capacity to pay	0.46	0.56	0.96	1.13	1.74	0.97
SES 2006						
-10%of total consumption	2.35	2.8	3.81	4.52	6.25	4.03
-40%of household capacity to pay	0.38	0.58	0.66	0.67	1.47	0.77

Another study showed that the percentage of OOP payments to total household health expenditure reduced from 34 in 2000 to 12 in 2014. And the prevalence of health-impoverished households also declined by 37.4%.[32] UCS has provided a safety net to all socioeconomic levels and decreased the prevalence of CHE and impoverishment.[74] However, there are some households still suffering the financial burden. The summarized reasons for experiencing CHE and impoverishment despite Thailand's Universal Coverage Scheme were using health services not covered by the UCS benefit package, using services from private facilities, or bypassing the designated providers without proper referrals.[37]

Weraphong J et al. explored the burden of OOP health expenditure on urban inhabitants in Nakhon Sawan Municipality. The most commonly reported illness were hypertension, diabetes, and common colds. Household OOP medical costs were mostly from spending at drug stores and private clinics. The main direct non-medical costs were for transportation and food. Factors related to CHE were CSMBS cardholders and the use of public hospitals, private hospitals, and clinics. CHE was related to non-medical costs and time loss for indirect costs. Catastrophic rates of the poor were 12.5 and 30.4% from direct and non-medical costs, respectively. The rates for the non-poor were lower.[103]

The study by Tangcharoensathien V et al. compared the incidence of CHE and impoverishment pre and post-UHC. Using the 10% threshold, the incidence of CHE dropped from 6% in 1996 to 2% in 2015. The incidence of impoverishment against the national poverty line reduced from 2.2% in 1996 to 0.3% in 2015.[36]

Even though many studies showed the success of UCS in the reduction of financial burden among Thai households, financial hardship remained. Furthermore, these studies did not focus on OOP spending for a specific illness, especially CKD.

1.4.5 The impact of Thailand's Universal Health Coverage on the financial burden of CKD treatment and dialysis modalities

The study by Prakongsai P et al. was conducted in early 2005 when access to KRT for UCS members depended on patients' ability to pay. This study assessed the economic impact of KRT costs on 20 Thai households with ESKD patients. In this study, poorer families with ESKD patients spent 25 to 68% of their monthly household income on health. The burden of the KRT cost varied by household economic status. KRT cost contributed 9-51% and 17-74% among wealthier and middle households. The poorer household was forced to sell assets, fall into debt, and become impoverished. The KRT cost burden also affects other household members. For low-income families, the relatives had to provide financial support for the patients. The annual cost of dialysis alone was more than $ 6,500, and erythropoietin's annual fee was approximate $USD 3,876. Apart from the dialysis cost and injected medication (erythropoietin for anemia treatment), there were travel and food expenses and time cost for household caregivers. On average, households spent 25-48% of total income or 31-52% of total expenditure on dialysis treatment.[31] The coping mechanisms in the poorer patients were reducing the frequency of dialysis, treating anemia with blood transfusion, reducing food consumption, using public transport to hospitals, and borrowing money at high-interest rates.[97] This financial burden of KRT pushed poor households to face financial catastrophe and to fall into impoverishment. The inadequate dialysis dose and insufficient erythropoietin injections to correct anemia was the primary cause of death for more deficient patients. More affluent patients had higher survival rates and better quality of life than poorer patients because of adequate dialysis and medications. The catastrophic impact was more significant among poorer households with low and irregular incomes than wealthier families due to a lack of safety insurance.[31]

Thailand's UCS benefit package initially excluded KRT because of its high cost and the incapacity to deliver the services equitably. The cost of dialysis (USD 7,000 per patient per year) incurred is catastrophic to patients and families under UCS. Most patients cannot afford regular treatment and eventually die from the inadequate treatment. On the contrary, the KRT patients under CSMBS and SSS who have higher social status, job security, and employment than patients under UCS have full reimbursement for KRT.[32] Therefore, the political decision to include KRT in the UCS package implemented in 2008 under the 'PD First Policy' is based on ethical and equity concerns.[88]

The summary of the detailed characteristics of each health service scheme on CKD care is in table 1.5.

Table 1.5 Characteristics of Thailand's primary health insurance schemes. [32]

Health insurance scheme	**UCS**	**SSS**	**CSMBS**
Population coverage	the rest of the Thai people	private sector employees, excluding dependants	government employees and dependents
Percentage coverage	75	16	9
Source of revenue	General tax	Tripartite contribution, equally shared by the employer, employee, and government	General tax, Non-contributary scheme
Mode of provider payment	Capitation for outpatient and global budget plus Diagnostic Related Group (DRG) for inpatient	Inclusive capitation for both outpatient and inpatient plus additional adjusted payments for accident and emergency and high-cost care	Fee for service, direct disbursement to mostly public providers, and DRG for inpatient treatment
Access to service	Registered contractors, the network of public hospitals (contracting unit for primary care)	Registered public and private contraction	Free choice of public provider
Dialysis cost	Free for PD as the first modality,	Fixed fee for HD and PD	Free for HD, PD

Health insurance scheme	UCS	SSS	CSMBS
	Reimbursable for HD if contraindicated to PD	Monthly extra payment for PD And HD (some private providers)	Additional cost for some medical supply
Medicines	Free for medicines under the essential drugs list Erythropoietin through capitations	Free for medication under the essential drugs list Erythropoietin through capitations	Free for medicines under the essential drugs list Erythropoietin as needed
Surgical procedures associated with dialysis (vascular access, Tenchkoff catheter insertion)	Fixed fee	Fixed fee	Free for public provider

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme, PD Peritoneal dialysis, HD Hemodialysis

Even though studies have demonstrated that kidney transplantation is more cost-effective than dialysis.[104,105] But only a few kidney transplants have been performed in low and middle-income countries, including Thailand. The significant barriers to kidney transplantation are the limited supply of donated kidneys, lack of infrastructure, shortage of specialized health professionals in the public sector, and high investment costs. Therefore, dialysis, including PD and HD, is the most accessible KRT option for ESKD patients worldwide, including Thailand.[88]

PD and HD have their advantages and disadvantages, as demonstrated in Table 1.6.[90]

Table 1.6 Compare the characteristics between HD and PD. [90]

	HD	**PD**
Advantages	-the patient does not need to be taught to carry out treatment -social support system -applicable to a majority of patients	-better survival rate within the first 1-2 years -increased patient autonomy -lower cost -preserve residual kidney function
Disadvantages	-increase time and cost of travel to the dialysis unit -increased risk of infection, complications	-patients need to maintain good hygiene -increased risk of infection -potential burnout of patients or caregivers

The selection of dialysis modalities (HD or PD) depends on patient motivation, preference, geographic distance from a dialysis unit, physician and/or nurse bias, patient education, caregiver, and reimbursement policy. Many studies have compared the cost and outcomes between HD and PD. There was no significant difference in overall patient survival between HD and PD. Regarding the quality of life, PD patients reported higher satisfaction and ability to travel, but HD patients reported better staff and social interaction and less fear of isolation.[106]

The study by Teerawattananon Y et al. compared the economic evaluation of palliative management versus PD and HD. Using the societal perspective, the incremental cost-effectiveness ratio (ICER) of PD was 772,000 baht per quality-adjusted life-year (QALY) gained, of HD 806,000 baht per QALY compared with palliative care. This study suggested that PD was a better choice than HD.[107]

Studies from other countries confirmed the benefit of PD as the first dialysis modality. The study from Hong Kong by Wong CKH et al. evaluated lifetime cost-effectiveness analysis of first-line dialysis modalities for patients with ESKD under the PD first policy. This study found that for both healthcare provider and societal perspectives, PD as the first-line dialysis modality was cost-saving relative to hospital-based HD.[108]

The report by Villa G et al. on costs analysis of the Spanish Renal Replacement therapy program found that the average annual costs (incidence and prevalence) were 2,651 and 37,968 euros for HD, 1,808 and 25,826 euros for PD, and 38,313 and 6,283 euros for kidney transplantation. The indirect cost was 8,929 euros for HD, 7,429 euros for PD, and 5,483 euros for KT. This study demonstrated that PD is more cost minimization than HD.[109]

From the evidence mentioned above of the benefit of PD, the Thailand government decided to implement Peritoneal Dialysis First (PD First) policy in 2008 to provide free dialysis for ESKD patients under UCS. This PD First policy includes full reimbursement of PD as the first dialysis modality and only reimburses HD for patients with contraindications for PD. PD costs are reimbursed through a fixed fee, and medicines and supplies are through central and bulk purchasing. The National Health Security Office (NHSO) establishes the networks between dialysis centers, district hospitals, and other public healthcare facilities. It also creates partnerships with private facilities for treatments with limited capacity in government facilities through fixed prices for reimbursement.[88] Between 2008-2013, the number of ESKD patients on KRT increased by 120%. The PD First policy has prolonged the lives of about 50,000 ESKD patients. The PD First policy has achieved the goal of efficiency, equity, and protection of households from deepened financial burdens. Patients on PD can manage at home with no traveling costs, unlike HD 2-3 sessions per week, which needs patients to travel to a dialysis unit that is not accessible to poor rural people. Therefore, this policy can decrease OOP payments in direct non-medical costs (transportation, informal care) and indirect expenses (absenteeism, sick leave, and opportunity loss).[32]

In Thailand, public hospitals set up PD services for patients in rural areas, so they do not need to travel to healthcare facilities. Therefore, PD can potentially reduce the OOP spending of ESKD patients and families.[90] The studies in Thailand by Teerawattannanon Y et al. demonstrated that PD has a relatively lower cost for providers (including capital investment), less healthcare provider staff needed, and lower patient travel time and cost. [107]

The study by Thammatacharee N et al. on the changing patterns of access to the KRT program in Thailand found that since the inclusion of KRT in the UCS, the number of new patients with ESKD aged 20-69 years registered with the dialysis program increased over time. For patients aged 20-40 years, the dialysis program took up to 400 new patients for every 1000 new ESKD diagnoses. From 2009 to 2017, there was a constant increase in PD patients. However, HD patients outnumbered PD patients. By the end of 2017, the number of patients

increased to 20,000 for PD and 15,000 for HD. The number of KT patients was extremely small relative to PD and HD patients. The predicted number of patients on KRT corresponded to an annual growth rate of 7.2-7.4% for PD and HD.[110] The increased number of KRT patients will result in a financial burden to patients and the country.

Tiansaard J et al. studied the financial burden of 101 Thai HD patients in 2017. This study used the Financial Burden Survey to evaluate the financial burden. The result showed that 15.84% of HD patients perceived the severe financial burden of dialysis treatment.[111]

Chapter 2
Research methodology

2.1 Study design

This study is a nationwide, cross-sectional study conducted in Thailand between June 2019 and January 2021. It is a health economic part of the CORE-CKD study (TCTR20211209001) (www.thaiclinicaltrials.org), which is the prospective cohort, observational study to assess clinical course and outcomes of different staged CKD patients. It is also reported by following The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.[112]

2.2 Study locations

Eleven hospitals already participated in the CORE-CKD study were selected for this study according to their locations in all regions of Thailand. The distribution of all 11 medical centers was as the followings; 3 centers from the Northern region, two from the Southern region, three from the Northeastern region, one from the Eastern region, and two from the Central region. The hospitals in this study were university and non-university (provincial) hospitals where nephrologists provide CKD care. These selected hospitals provided care for early stages of CKD and ESKD patients who needed kidney replacement therapy.

1. university hospitals:

Central region:	Faculty of Medicine, Ramathibodi hospital
	Bhumibol Adulyadej hospital
Northern region:	Faculty of Medicine, Chiangmai hospital
	Faculty of Medicine, Naresuan hospital
Northeastern region:	Faculty of Medicine, Khonkaen hospital
Southern region:	Faculty of Medicine, Songklanagarind hospital

2. provincial hospitals:

Northern region:	Nakornping hospital, Chiangmai
Northeast region:	Sunpasithiprasong hospital, Ubon Ratchathani
	Korat hospital, Nakhon Rajchaseema
Southern region:	Wachira hospital, Phuket

Eastern region: Somdej pranangchao Sirikit hospital

The selected types of the hospital (university vs. provincial hospitals, different regions of Thailand) are planned to cover the differences in the characteristics of patients in terms of socioeconomic status, health insurance schemes, and CKD practices. This strategy would help to better the generalizability of the study results.

2.3 Target population

We recruited consecutive CKD patients who were at least 18 years of age and covered by health insurance schemes; Universal Coverage Scheme (UCS), Social Security System (SSS), and Civil Servant Monetary Benefit Scheme (CSMBS). We excluded patients with incomplete expenditure data or those who were entirely self-pay from the analysis.

2.4 Study population

CKD patients who meet the eligibility criteria and visit 11 study hospitals

Eligibility criteria

1. CKD 15-60: with eGFR 15-60 ml/min/1.73m^2
2. CKD<15: with eGFR <15 ml/min/1.73m^2 (non-dialysis dependent)
3. HD: patients who have been on hemodialysis for $\geq$ 1 year
4. PD: patients who have been on CAPD for $\geq$ 1 year

Exclusion criteria

1. currently participating in an intervention trial
2. short life expectancy (less than three months), e.g., from cancer, HIV
3. previously failed kidney transplant

2.5 Sample size calculation

The proportion of CHE compared between PD and HD from the study by Waleekhachonioet O et al. was used for sample size calculation .[113]

The proportion of CHE in PD = 65%

The proportion of CHE in HD = 45%

The ratio of PD: HD 46:42

The sample size is estimated using an alpha of 0.05 and a power of 0.80.The desired sample size was 92 patients in PD and 102 patients in HD. In this study, we were also interested in the financial burden of pre-dialysis CKD patients. Then we enrolled CKD patients with eGFR 15-60 and < 15 ml/min/1.73m^2 into our study.

2.6 Sampling method

Patients (n=100-200) were randomly selected from each hospital. Then the eligible patients in each CKD group were enrolled consecutively at each participating hospital.

2.7 Study procedures

1. questionnaire development

Questionnaire comprises of

1.1 form for the collection of demographic and clinical data

1.2 questionnaire for collection of expenditure

The first draft of the questionnaire was developed with a literature review and input from dialysis nurse, nephrologists, and health economists. To reduce the measurement error, the comprehension test was done as a pilot test with a group of 20 CKD patients by the principal investigator and the study coordinator. After testing and adjusting with the investigator team, the final draft of the questionnaire was designed into electronic form for convenience in data entry and analysis. This electronic questionnaire, "CORE-CKD Thailand health economic study' is operated according to CTMS Clinical Trials Management System) under http://coreckdeco.works.ncrc.in.th, which is a free online research tool of the National Clinical Research Center (nCRC).

The questionnaire consisted of

1. demographic and clinical characteristic data: age, sex, duration of CKD or dialysis, type of dialysis (HD or PD), comorbidities (diabetes, hypertension, dyslipidemia, cardiovascular disease), laboratory results for analysis: serum creatinine (SCr), estimated GFR (eGFR) calculated by using the Chronic Kidney disease Epidemiology Collaboration (CKD-EPI).[114]

2. patient income, food expenditure, and total household consumption spending in a reference period of one month preceding the interview

3. out-of-pocket spending in the reference period of six months before the interview.

3.1 out-of-pocket expenditures for medical costs consisted of co-payment which was not covered by public or private health insurance as the followings: medications, medical equipment at outpatient clinic visits at study hospital and other hospitals, in-hospital care, dialysis incurred at study and other hospitals for hemodialysis patients, self-prescribed medications, food nutrition, and herb.

3.2 out-of-pocket non-medical expenditures consisted of expenses for food, transportation, and accommodation for the patient and accompanying persons, both outpatient clinic visits and hospital admissions. The spending for a house renovation, facilities, or expenses to improve health status and formal caregiver were also included as OOP spending for non-medical expenditure

2. After ethical approval of the research protocol, the investigator contacted the study coordinator at each participating hospital for the appointment for data collection. The eligible patients will be invited and asked for written consent to join the study**.** Then each study participant's identification will be de**-**identified by assigning a patient identification code (ID code) by the designated study coordinator nurse**.** Access to patient identification will be limited and only by this designated nurse**.**

3. the process of data collection:

The process of data collection consisted of the following:

1. patient interview (family members if the patient was not aware of the expenditure)

2. hospital chart review

The demographic data, clinical data, and all expenditures, as well as out-of-pocket spending, are obtained by interviewing at every study site using the established questionnaire. The appendix is the questionnaire used in the study.

2.8 Data analysis

2.8.1 Data management

1. Data exported from the electronic questionnaire was double-checked to ensure the correctness of the data. In addition, data were checked for range and outliers.

2. For categorical data such as demographic data, health schemes, and comorbidity will be demonstrated in number and percentage. For continuous variables, the mean with standard deviations and/or median with interquartile range (IQR) will be calculated depending on the data distribution.

3. All cost data was calculated to annual expense in Thai baht, adjusted with the cumulative inflation rate from the year of data collection to 2021, and then converted to US dollars using the exchange rate in January 2021.

4. Out-of-pocket expenditures were calculated.

4.1 Out-of-pocket expenditures for medical costs consisted of co-payment which was not covered by public or private health insurance as the following: medications, medical equipment at outpatient clinic visits at study hospital and other hospitals, in-hospital care, dialysis incurred at study and other hospitals for hemodialysis patients, self-prescribed medications, food nutrition, and herb

4.2 Out-of-pocket spending for non-medical expenditures consisted of expenses for food, transportation, and accommodation for the patient and accompanying persons, both outpatient clinic visits and hospital admissions. The cost for a house renovation, facilities or expenses to improve health status, and formal caregiver was also included as OOP spending for non-medical expenditure

4.3 Total OOP expenditure for health was the combination of OOP expenditures for medical costs and OOP spending for non-medical expenditures

5. Calculation of catastrophic health expenditure (CHE)

Definition of CHE [115]

Catastrophic health expenditure (CHE) is the expenditure for health care services that can compromise a household's financial ability to maintain its subsistence needs. CHE incurs when OOP payment exceeds a certain proportion of household income, and the family needs to reduce the expenditure on basic necessities.

Definition of subsistence expenditure [115]

Subsistence expenditure is the expenditure for household subsistence needs such as food. But if using actual food spending as subsistence, wealthy households may spend money

on expensive non-essential food. Such spending will increase the risk of CHE among wealthy families while decreasing the risk among the poor.

From WHO methodology, subsistence expenditure is defined as the average food expenditure of households whose food expenditure share is in the 45^{th} and 55^{th} range**.** The food expenditure shares in the 50^{th} percentile are considered the poverty line**.** This calculation is more prevalent among studies because it gives a more reasonable risk of CHE among different socioeconomic groups and can compare the results internationally**.**

Definition of total household consumption expenditure[115]

According to the life cycle hypothesis, effective income needs to consider the net earning income and other informal income, such as borrowing money, future income, and selling assets. This view is because the income can fluctuate during the whole year. Therefore, using the entire year's income data will better reflect how the households earn and spend money.[115] But it is not practical to get the whole year's data. Therefore, using the data within one month in the survey study is more common.

Total household consumption expenditure is more frequently used as the proxy of effective income. The benefits of using total household expenditure are

1. The variance of current household expenditure is less than the variance of the actual income over time. When calculating CHE, it recommends not including the effect of random shocks on income. Therefore, using household expenditure as the income proxy is better than the actual income because of less variation.
2. The household expenditure is more reliable than the actual income in reflecting the household's capacity in payment for goods or health care services. Furthermore, the participants may not reveal their actual income to the study. They usually tend to be more comfortable telling the expenditure than income.

Definition of capacity to pay [115]

According to WHO, the capacity to pay is the adequate income after spending for basic subsistence.

The methods for calculation of CHE:

There are two approaches to determining CHE.

Method 1 WHO 2005 method: capacity to pay approach

CHE based on ability-to-pay or capacity to pay **(**ctpay**)**

= OOP/ctpay

capacity to pay = X- S_{exp}

X = total household consumption expenditure

S_{exp} = subsistence expenditure

The threshold of household expenditure to determine CHE varied among studies. World Health Organization considers CHE when OOP payment for health care service is equal to or exceeding 40% of a household's non-subsistence income or capacity to pay. Therefore, we used 40% as the threshold for CHE in this study.

This method uses a food share- based poverty line for estimating subsistence expenditure. The poverty line is food expenditure that shares the 50^{th} (45^{th}-55^{th}) percentile of total food expenditure.

Variables:

FES_h =Food expenditure share for household

FE_h = food expenditure of household

TE_h = total expenditure of household

HES = household equivalent size

Coefficient β = household scale multiplier. It is used for adjusting the subsistence expenditure to account for economies of scale at the household level when its size increases. The value of 0.56 obtains from a regression equation based on 59 countries of the form:

$$\ln(FE_h) = \ln(k) + \beta \ln(HS) + \Sigma \gamma_i country$$

HS = household size

EFE_h = equivalent food expenditure of household

PL = poverty line

SE_h = Subsistence expenditure of household

$ctpay_h$ = household's capacity to pay

CHE = catastrophic health expenditure

Steps to calculate CHE:

Step 1 calculate food expenditure share (FES_h) for each household

FES_h = Food expenditure share for household

$$\frac{FE_h \text{ (food expenditure of household)}}{TE_h \text{ (total expenditure of household)}}$$

Step 2 generate the equivalent household size (HES) for each household

HES = HS (household size)$^{\beta}$, $\beta = 0.56$

Step 3 calculate equivalent food expenditure (EFE_h) by dividing each household food expenditure (FE_h) by the equivalent household size (HES)

$$EFE_h = \frac{FE_h \text{ (household food expenditure)}}{\text{HES (equivalent household size)}}$$

Step 4 calculates the poverty line by identifying food expenditure shares of total household expenditure that are at the 45th and 55th percentile across the whole sample (FES_h45 and FES_h55) and then calculating the average of the food expenditure of the households in the 45th to 55th percentile range to obtain the subsistence expenditure per capita.

Poverty line (PL) = average of EFE_h, where $FES_h45 < EFE_h < FES_h55$

Step 5 calculate the subsistence expenditure for each household (SE_h)

$SE_h = PL * HES$

Step 6 calculate household's ctpay

$ctpay_h$ = non-subsistence effective expenditures of the household

$ctpay_h = TE_h - SE_h$ if $SE_h \leq FE_h$

$ctpay_h = TE_h - FE_h$ if $FE_h < SE_h$

Step 7 calculates the ratio of OOP payments to household's capacity to pay

$$\text{OOP ratio} = \frac{\text{OOP spending}}{ctpay_h}$$

Step 8 Catastrophic health expenditure (CHE)

CHE occurs when OOP spending for health care services of household equal or exceed the non-subsistence spending or the pre-defined percentage of capacity to pay. The threshold varies according to the researchers. We used a threshold of 40%.[42]

CHE is defined as 1 if the OOP ratio > threshold and 0 otherwise.

CHE = 1 if OOP ratio $\geq$ threshold (0.4)

0 if OOP ratio < threshold

Step 9 Impoverishment or poor household incurs when total household expenditure exceeds the computed subsistence expenditure.

$Poor_h = 1$ if $TE_h > SE_h$

Method 2 the proportion of total household expenditure approach

This method compares the ratio of OOP spending/total household expenditure to the pre-defined threshold. The patient will develop CHE If this ratio is more than this threshold.

CHE = OOP spending > 10% of total household expenditure

Even though this method is simpler than the WHO method, it has a limitation in determining CHE compared to WHO calculation because CHE should be calculated by comparing OOP spending with the remaining income after subsistence expenditure. Rich households may spend OOP payments more than the threshold without developing catastrophe.

6. calculation of the proportion of patients with pre-out-of-pocket impoverishment and medical impoverishment

Definition of pre-out-of-pocket impoverishment

Pre-Out-of-pocket impoverishment means already poor households before paying out-of-pocket for health care services.

Definition of medical impoverishment

Medical impoverishment means the OOP payment, which pushes the household into poverty after paying for health care services. Poverty can also be based on the poverty line on the share of total expenditure on food, as WHO recommended.

Calculation of pre-out-of-pocket and medical impoverishment

1. Pre-out-of-pocket impoverishment (pre-OOP impoverishment) incurs when total household expenditure exceeds the computed subsistence expenditure.

   Poor = 1 if $TE_h < SE_h$,

   TE : total household expenditure

   SE: computed subsistence expenditure

2. Medical impoverishment (Post out-of-pocket impoverishment) means household which is not poor but becomes poor after out-of-pocket payment for healthcare services.

   Medical impoverishment = 1 if TE > SE and TE-OOP < SE,

TE: total household expenditure

SE: computed subsistence expenditure

OOP: out-of-pocket spending for healthcare service

7. Analysis of the proportion of CKD patients with CHE, pre-OOP, and medical impoverishment among quintiles of socioeconomic status

The equivalized per capita total household expenditure was used to represent socioeconomic status and ranked into five quintiles from the poorest to the richest. The incidence of CHE, pre-OOP impoverishment and medical impoverishment were compared among these quintiles.

2.8.2 Data analysis

Analysis of factors associated with CHE by multivariable logistic analysis

We performed multivariable logistic regression analysis to determine factors affecting CHE, reporting as adjusted odds ratios (ORs) with 95% Confidence Intervals (CIs) controlling for the following covariates: age, gender, types of health insurance schemes, groups of CKD, comorbidities (diabetes, hypertension, dyslipidemia, and cardiovascular disease), annual patient income and the number of household members.

We expected that there would be some other differences in the characteristics among sites we did not collect, which may account for the variance among study sites. Therefore, the variance correction with cluster site was performed to correct the variance among study sites.

Because the benefit packages in each health insurance scheme differ among stages of CKD, there should be an interaction between health insurance schemes and groups of CKD. Therefore, we tested the interaction between groups of CKD and health insurance schemes in the models. We also calculated the probability of CHE among different CKD groups and health insurance schemes. Data analyses were performed using STATA 16.1, and significance was set at $p < 0.05$.

Sensitivity analysis

We performed a series of sensitivity analyses by

1) defining CHE10 as an OOP spending for health over the 10% threshold of total household consumption expenditure. [24,116]

2) defining impoverishment based on Thailand's National poverty line year 2019.[117]

2.9 Ethical consideration

This study was designed and conducted under ethical principles presented in the Belmont Report and the Declaration of Helsinki. Research Ethics Board at Central Research Ethics Committee approved the study (ID: COA-CREC 005/57).

The immediate health risk to participants was estimated to be not greater than minimal because the participants only responded to the questionnaire. Then each study participant's identification will be de-identified by assigning a patient identification code (ID code) by the designated study coordinator nurse**.** Access to patient identification will be limited and only by this designated nurse**.** The questionnaire did not include information that could identify the respondents, such as name and identification number. Therefore, the process of statistical analysis and report were anonymized.

This study will not provide direct benefit to the participants. However, we expected that knowledge gained from this study could identify the magnitude of the current financial burden among CKD patients under universal health coverage. Policymakers could use it to adjust the benefits package and improve the quality of CKD care in Thailand. Other developing countries that consider the inclusion of KRT in the benefits package could also use it.

The appendix is the certificate of ethical approval from the Research Ethics Board at the Central Research Ethics Committee and at each participating hospital.

Chapter 3
Results

3.1 Demographic and clinical characteristics

Of the initially recruited participants (n=1,239), we excluded two patients with incomplete expenditure data and thirteen patients who were entirely self-paid. (Figure 3.1).

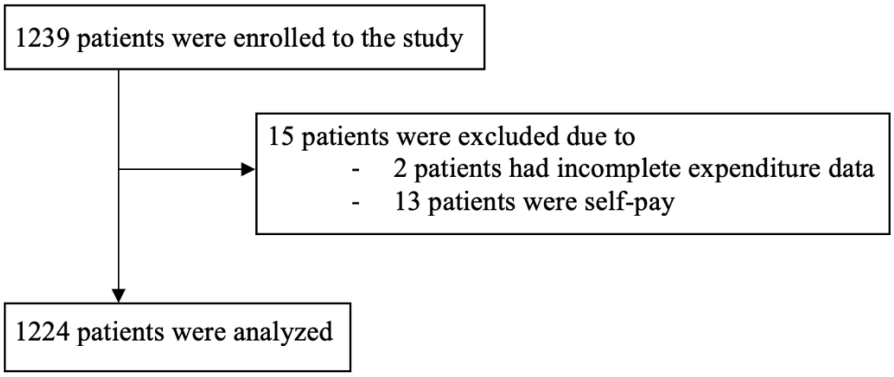

Figure 3.1 Study flow

There were 1,224 patients for analysis. The demographic and clinical characteristics are shown in Table 3.1. There were 435 (35.5%) with CKD15-60, 213 (17.5%) with CKD<15, 257 (21%) on PD, and 319 (26%) on HD. The entire study participants' mean(SD) age was 63.8 (14.3) years, and 44% were female. The percentage of patients under UCS, SSS, and CSMBS was 44.1, 8.9, and 47%, respectively. Hypertension was the most common comorbidity (91.6%), followed by dyslipidemia (71.2%) and diabetes (45.1%). There were more study participants from university hospitals than from provincial hospitals.

Table 3.1 Demographic and clinical characteristics.

Characteristics	Total (%)	CKD15-60(%)	CKD<15 (%)	PD (%)	HD (%)
Number of patients	1224	435	213	257	319
Demographic data					
Age (years) [a]	63.8 (14.3)	69.0 (12.2)	65.7 (13.2)	58.2 (14.8)	59.8 (14.3)
Female	538 (44)	170 (39.1)	117 (54.9)	115 (44.7)	136 (42.6)
Health insurance schemes					
UCS	540 (44.1)	153 (35.2)	108 (50.7)	185 (72.0)	94 (29.5)
SSS	109 (8.9)	24 (5.5)	15 (7.0)	11 (4.3)	59 (18.5)
CSMBS	575 (47.0)	258 (59.3)	90 (42.3)	61 (23.7)	166 (52.0)
Clinical characteristics					
eGFR(ml/min/1.73m^2) [b]	8(5-25)	32 (23-42)	9(7-13)	4 (4-6)	5 (4-6)
Duration of CKD (months) [b]		48 (22-108)	36 (20-68.5)	N/A	N/A
Duration of dialysis (months) [b]		N/A	N/A	35 (20-61.0)	58 (32-100)
Diabetes	552 (45.1)	203 (46.7)	111 (52.1)	109 (42.4)	129 (40.4)
Hypertension	1,121 (91.6)	377 (86.7)	196 (92.0)	242 (94.2)	306 (95.9)
Cardiovascular disease	188 (15.4)	60 (13.8)	28 (13.1)	44 (17.1)	56 (17.6)
Dyslipidemia	871 (71.2)	339 (77.9)	159 (74.6)	162 (63.0)	211 (66.1)
Sites of study					
Provincial Hospital	514 (42.0)	164 (37.7)	90 (42.3)	116 (45.1)	144 (45.1)
University Hospital	710 (58.0)	271 (62.3)	123 (57.7)	141 (54.9)	175 (54.9)

UCS Universal Coverage Scheme, SSS Social Security System, CSMBS Civil Servant Monetary Benefit Scheme

[a] mean (sd) (years), [b] median (IQR), [c] median (IQR) (ml/min/1.73m^2), [d] median (IQR) (months)

3.2 Patient income, total household expenditures, and OOP spending for health

From Table 3.2, the average annual patient income and total household expenditures in every CKD group of patients under UCS were lower than those under SSS and CSMBS.

When comparing all groups of CKD under UCS, there was no significant difference in patient income. However, PD patients had the lowest income compared to the other three groups of CKD. Among patients under SSS, PD and HD patients had lower income than non-dialysis CKD patients. On the contrary, PD and HD patients under CSMBS had higher incomes than non-dialysis CKD patients.

Patients under CSMBS spent total OOP for health more than the other schemes. In every health insurance scheme, dialysis patients spent total out-of-pocket for health higher than non-dialysis patients. Under UCS, total OOP for health in HD was over two times higher than PD and nearly three to six times higher than non-dialysis patients. Among patients with CSMBS, HD patients also spent the highest amount of total OOP for health. However, PD patients under SSS spent OOP for health more than HD and non-dialysis patients. (Table 3.2, Figure 3.2)

The OOP expenditure for medical costs at OPD visits was the main driver for OOP spending for medical expenses in every CKD group. (Supplementary Table S1)

The OOP spending for non-medical costs was higher than for medical costs in every health insurance scheme in all CKD groups except patients in CKD < 15 under SSS. For HD and PD patients, OOP spending for non-medical costs was higher than for medical costs in all three health insurance schemes. The OOP spending for non-medical costs contributed about 49.2-90.2% of total OOP spending in all groups of patients. OOP for non-medical costs contributed more than 50% for HD and PD patients. Travel cost was the main driver of OOP spending in HD, which accounted for 49.3%, 47.1%, and 44% of total OOP expenditure for health in HD under UCS, SSS, and CSMBS, respectively. While among PD patients, OOP spending for travel costs as the percentage of total OOP spending for health was 29% for patients under UCS, 14.6% for patients under SSS, and 22.9% for patients under CSMBS. (Figure 3.2, Supplementary table S1)

Table 3.2 Socioeconomic characteristics and out-of-pocket expenditures by CKD groups.

Characteristics	Total	CKD15-60	CKD<15	PD	HD	P-value
Socioeconomic characteristics						
UCS (%)	540 (100)	153 (28)	108 (20)	185 (34)	94 (18)	
Patient income [a]	1549	1612	2052	1259	1437	0.399
	(1221-1876)	(1092-2132)	(930-3174)	(874-1645)	(670-2204)	
Total household expenditures [a]	6174	5570	7193*	6414	5513	**0.023**
	(5767-6580)	(4940-6200)	(6013-8372)	(5735-7093)	(4670-6356)	
SSS (%)		24 (22)	15 (14)	11 (10)	59 (54)	
	109 (100)					
Patient income [a]	4170	7220	4304	3029*	3108*	**0.003**
	(3284-5055)	(4930-9509)	(2322-6286)	(326-5731)	(2,091-4124)	
Total household expenditures [a]	7077	7666	6951	7777	6738	0.821
	(6192-7961)	(6252-9080)	(5374-8528)	(5529-10026)	(5314-8163)	
CSMBS (%)	575 (100)	258 (44)	90 (16)	61 (11)	166 (29)	
Patient income [a]	6457	5891	5627	9436*	6693*	**0.032**
	(5731-7183)	(5152-6630)	(4190-7064)	(5295-13576)	(5266-8120)	
Total household expenditures [a]	9250	8682	8714	11070	9756	0.063
	(8681-9819)	(7905-9458)	(7338-10090)	(8650-13490)	(8728-10784)	
Out-of-pocket expenditures						
UCS (%)		153 (28)	108 (20)	185 (34)	94 (18)	
	540 (100)					
Out-of-pocket for medical expenditures [a]	286	112	179	325*[$]	619[#]	**0.001**
	(204-369)	(70-153)	(72-285)	(245-404)	(200-1038)	
Out-of-pocket for non-medical	494	191	447*	434*[$]	1156*[$ #]	**< 0.001**
expenditures [a]	(396-591)	(110-271)	(170-725)	(283-586)	(863-1449)	
Total out-of-pocket expenditures [a]	780	302	626*	759*[$]	1775*[$ #]	**< 0.001**
	(645-914)	(205-400)	(311-941)	(580-938)	(1262-2288)	
SSS (%)	109 (100)	24 (22)	15 (14)	11 (10)	59 (54)	
Out-of-pocket for medical	348	57	232	775	416	0.086
expenditures [a]	(192-504)	(12-103)	(78-386)	(396-1154)	(148-685)	
Out-of-pocket for non-medical	685	527	224	1,057	797	0.341
expenditures [a]	(434-936)	(-215-1269)	(39-409)	(-68-2182)	(516-1078)	
Total out-of-pocket expenditures [a]	1033	584	456	1832	1213	0.054
	(737-1329)	(-158-1327)	(206-706)	(580-3084)	(842-1585)	
CSMBS (%)	575 (100)	258 (44)	90 (16)	61 (11)	166 (29)	
Out-of-pocket for medical	297	204	225	381*[$]	451*[$ #]	**0.001**
expenditures [a]	(243-352)	(121-287)	(142-308)	(286-477)	(329-574)	
Out-of-pocket for non-medical	834	368	383	863*	1,790*[$ #]	**< 0.001**
expenditures [a]	(670-998)	(239-497)	(247-519)	(399-1328)	(1323-2258)	
Total out-of-pocket expenditures [a]	1131	572	608	1245*[$]	2242*[$ #]	**< 0.001**
	(951-1312)	(415-730)	(435-781)	(751-1739)	(1744-2740)	

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme. CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

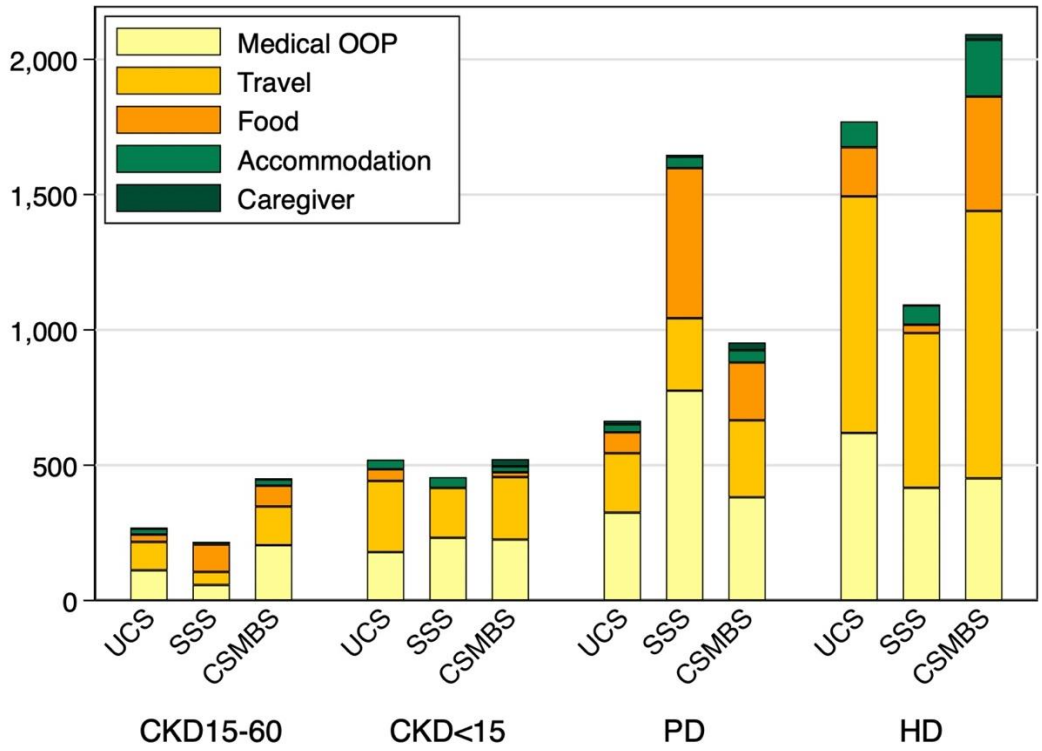

Figure 3.2 Breakdown of mean annual out-of-pocket cost by health insurance schemes and CKD groups.

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme. CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

3.3 The proportion of CHE, comparing among CKD groups and health schemes

The overall proportion of CHE40 was 40.8% (95% CI 35.4-46.1) for HD, 22.2% (95% CI 17.1-27.3) for PD, 9.9% (95% CI 7.1-12.7) for CKD 15-60 and 7.0% (95% CI 3.6-10.5) for CKD<15. The percentage of CHE in CKD15-60 and CKD<15 was 0-11%, less than HD and PD in every health scheme. The highest rate of CHE in HD was 50% in patients under UCS. In the PD group, the percentages of patients under SSS incurred CHE more than the other health schemes, but the number of patients was small (only four patients). (Table 3.3, Figure 3.3)

The sensitivity analysis using the threshold of more than 10% of total household expenditure showed a similar trend but a higher absolute percentage. (Supplementary Table S2) HD under UCS incurred the highest proportion of CHE [67%, (95% CI 57.5-76.5)].

Table 3.3 Proportion of Catastrophic Health Expenditure (CHE40) and impoverishment by CKD groups.

	Total (95%CI)	CKD15-60 (95%CI)	CKD<15 (95%CI)	PD (95%CI)	HD (95%CI)	P-value
CHE40 [a]						
UCS	19.6% (16.3-23.0)	8.5% (4.1-12.9)	9.3% (3.8-14.7)	19.5%*$ (13.8-25.2)	50.0%*$# (39.9-60.1)	**< 0.001**
SSS	24.8% (16.7-32.9)	8.3% (-2.7-19.4)	0.0% (0.0-0.0)	54.5%*$ (25.1-84.0)	32.2%*$ (20.3-44.1)	**0.001**
CSMBS	19.5% (16.2-22.7)	10.9% (7.1-14.6)	5.6% (0.8-10.3)	24.6%*$ (13.8-35.4)	38.6%*$# (31.2-46.0)	**< 0.001**
Medical impoverishment						
UCS						
Pre-out-of-pocket impoverishment [b]	16.1% (13.0-19.2)	18.3% (12.2-24.4)	11.1% (5.2-17.0)	15.7 % (10.4-20.9)	19.1% (11.2-27.1)	0.348
Medical impoverishment [c]	12.1% (9.1-15.1)	8.0% (3.2-12.8)	3.1% (-0.4-6.6)	11.5%$ (6.5-16.6)	31.6%*$# (21.1-42.0)	< 0.001
SSS						
Pre-out-of-pocket impoverishment [b]	5.5% (1.2-9.8)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	9.1% (-7.9-26.1)	8.5% (1.4-15.6)	0.374
Medical impoverishment [c]	13.6% (7.0-20.2)	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	24.1% (12.7-35.5)	**0.016**
CSMBS						
Pre-out-of-pocket impoverishment [b]	3.7% (2.1-5.2)	3.9% (1.5-6.2)	4.4% (0.2-8.7)	4.9 % (-0.5-10.3)	2.4% (0.1-4.7)	0.668
Medical impoverishment [c]	7.6% (5.4-9.8)	4.8% (2.2-7.5)	4.7% (0.2-9.1)	6.9% (0.4-13.4)	13.6%*$# (8.3-18.9)	**0.011**

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme, 95% CI, 95% Confidence Interval

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

*P-value <0.05 vs CKD15-60, $ P-value <0.05 vs CKD<15, # P-value <0.05 vs PD

[a] The percentage of households in which out-of-pocket payments for health care was at least 40% of the household capacity to pay

[b] The percentage of households in which total household expenditure was less than computed subsistence expenditure

[c] The percentage of households in which total household expenditure after paying out-of-pocket for health was less than computed subsistence expenditure

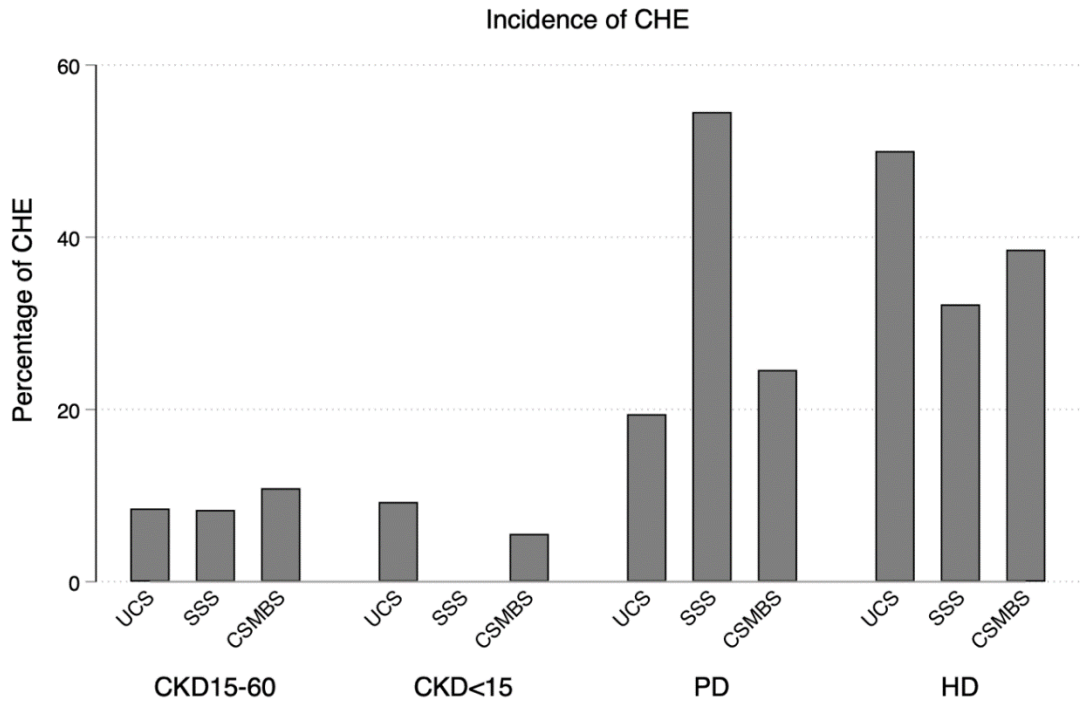

Figure 3.3 The incidence of CHE according to CKD groups and health insurance schemes.

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme, CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

3.4 The proportion of CHE across health schemes, groups of CKD, and quintiles of total household expenditures

Figure 3.4 demonstrates the percentages of CHE among groups of CKD patients across quintiles of total household expenditures in overall study participants. More patients in the poorest quintile experienced CHE than the wealthiest quintile in every CKD group. Dialysis patients incurred CHE more than non-dialysis patients, with the highest incidence of CHE in HD patients across all quintiles. 75.4% of HD patients in the poorest quintile incurred CHE. (Supplementary Table S3)

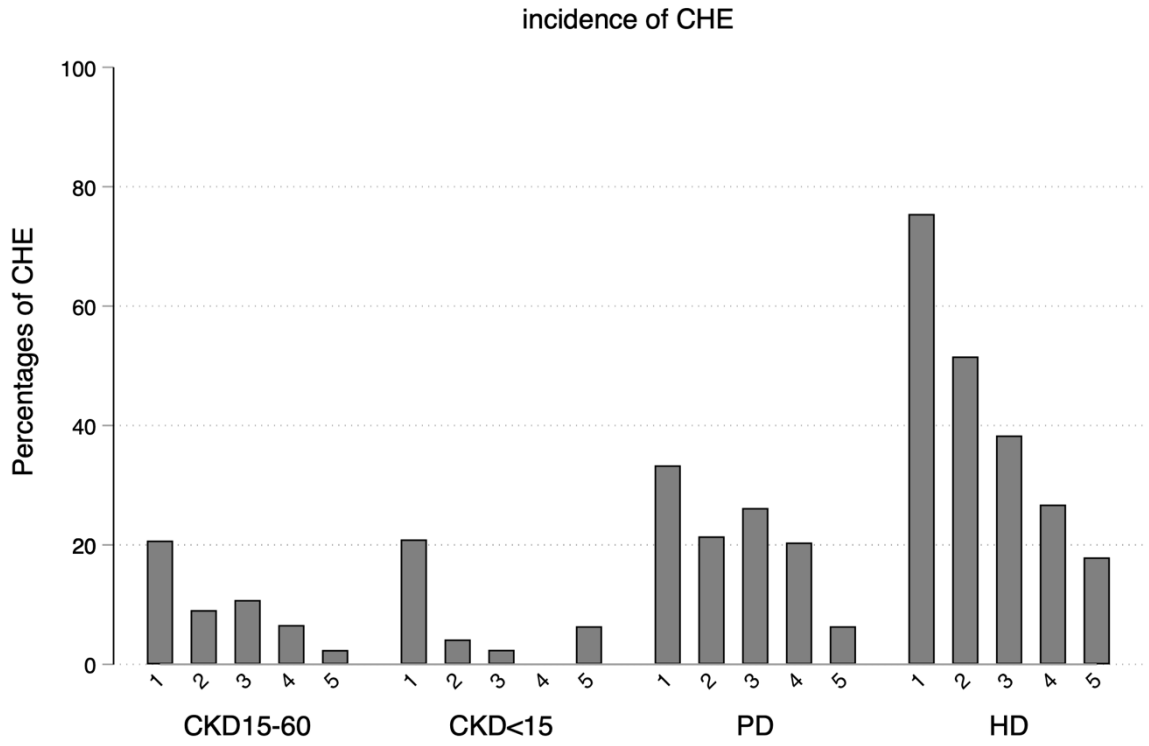

Figure 3.4 The percentages of CHE according to CKD groups across quintiles of total household expenditures.

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme, CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

When we considered CHE in CKD groups and quintiles of total household expenditure in each healthcare scheme. We found that in patients under UCS, HD patients suffered CHE higher than PD and non-dialysis CKD, with the highest percentage in the poorest quintile. There were 81.8% (95% CI 65.7-97.9) of HD patients in the poorest developed CHE. (Figure 3.5A, Supplementary table S4A) Among patients under SSS, dialysis patients incurred CHE higher than non-dialysis patients, with the highest proportion among PD patients. (Figure 3.5B, Supplementary Table S4B) For CSMBS, the proportion of dialysis patients who incurred CHE was higher than non-dialysis patients. The highest proportion of CHE was among the poorest group. (Figure 3.5C, Supplementary table S4C) With the sensitivity analysis, we found a similar trend.

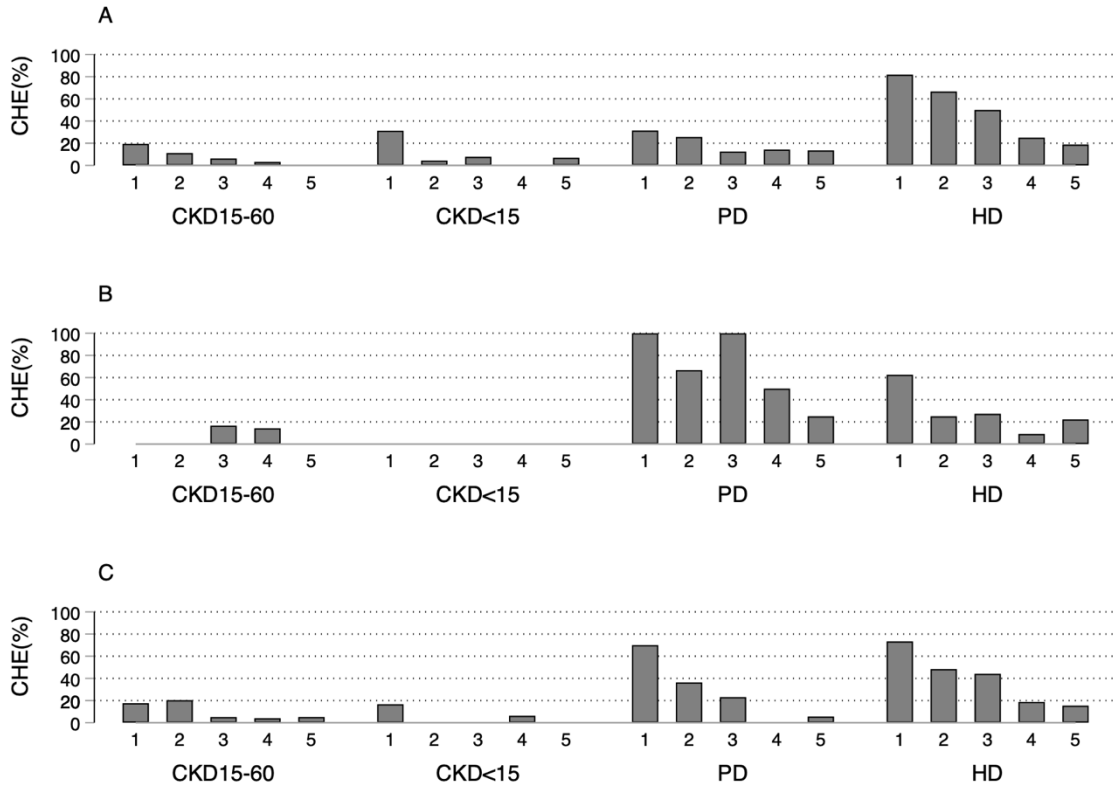

Figure 3.5 Socioeconomic status quintiles-specific proportion of Catastrophic Health Expenditure (CHE40) under different schemes. A) UCS; B) SSS; C) CSMBS

CHE40 is defined as households in which out-of-pocket payments for health care were at least 40% of the household capacity to pay. UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme. CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

3.5 The proportion of pre-OOP and medical impoverishment compared among CKD groups and health schemes

Table 3.3 and Figure 3.6 demonstrate the incidence of pre-OOP and medical impoverishment among CKD groups by different health schemes. There were more patients under UCS (16.1%) with pre-OOP impoverishment than SSS (5.5%) and CSMBS (3.7%). Among patients under UCS and CSMBS, the proportion of pre-OOP impoverishment was similar across CKD groups. Dialysis patients suffered more medical impoverishment than non-dialysis patients with HD suffered the most in every health insurance scheme (31.6% under UCS, 24.1% under SSS, and 13.6% under CSMBS).

The sensitivity analysis using the poverty line to define impoverishment showed a similar trend. HD patients still had the highest medical impoverishment in all health schemes. The proportion of medical impoverishment in HD patients was 20.2% in UCS, 10.2% in SSS, and 6% in CSMBS. (Supplementary Table S2)

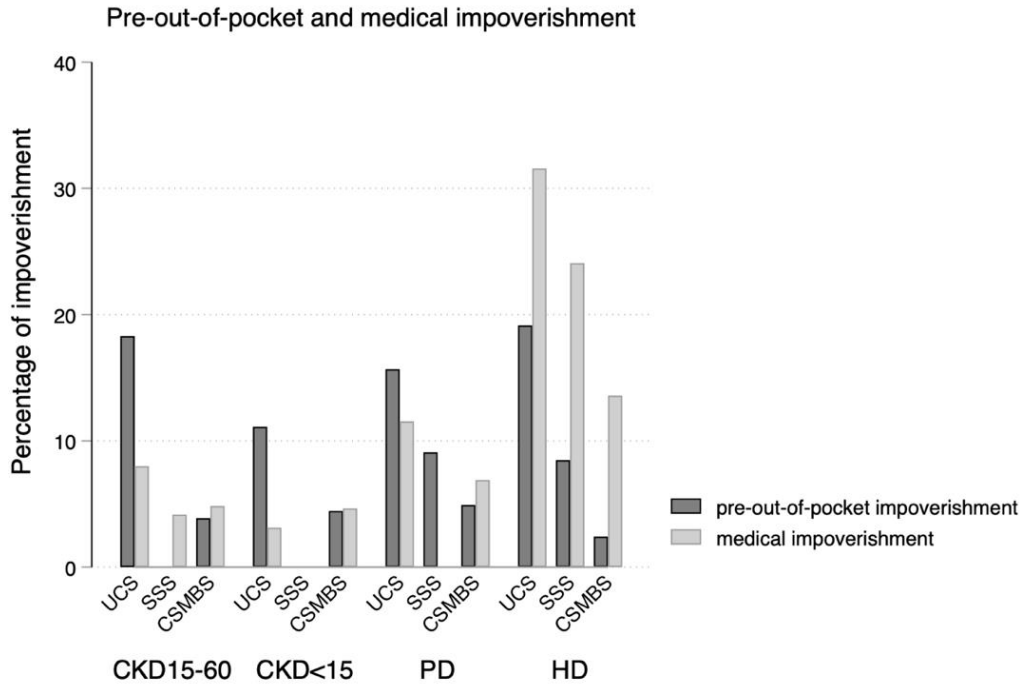

Figure 3.6 The percentage of poor[a] and medical impoverishment[b] according to CKD groups and health schemes.

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme,

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure

[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

3.6 The proportion of pre-OOP and medical impoverishment across health schemes, groups of CKD and quintiles of total household expenditures

The proportion of pre-OOP impoverishment was relatively similar across all CKD groups and found only in the poorest quintile of socioeconomic status. For medical

impoverishment, the proportion was highest in HD patients and among the poorest. (Figure 3.7 and Supplementary Table S5)

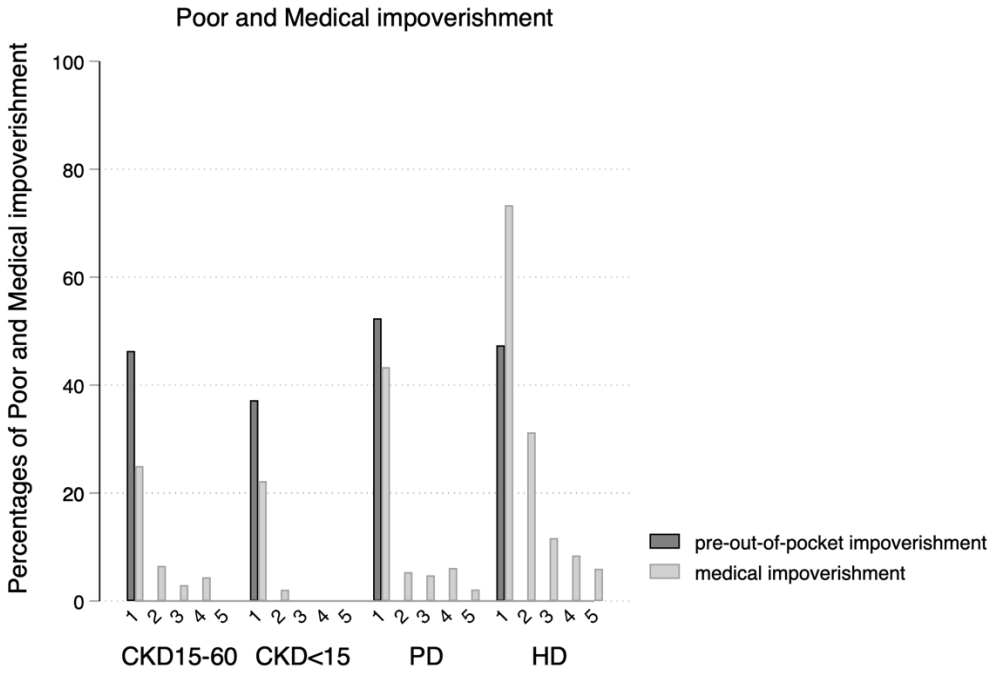

Figure 3.7 The percentage of pre-OOP [a] and medical impoverishment [b] according to CKD groups across quintiles of total household expenditure.

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme,
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure

[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

The proportion of pre-OOP and medical impoverishment across quintiles of socioeconomic status in each healthcare scheme was compared, as shown in figure 3.8.

Among UCS, the proportion of pre-OOP impoverishment was found only in the poorest group in every CKD group. The highest proportion of medical impoverishment was found in HD (100%), followed by PD (66.7%) and pre-dialysis CKD (50%). (Figure 3.8A, Supplementary Table S6A)

Among SSS, HD patients in every quintile of socioeconomic status developed medical impoverishment, with the highest among the poorest. (Figure 3.8B, Supplementary Table S6B)

HD patients under CSMBS incurred medical impoverishment higher than the other CKD groups, especially in the poorest quintile. 54.5% of HD patients in the poorest quintile developed medical impoverishment compared to 28.6% in PD and 12.2-20% in pre-dialysis CKD. (Figure 3.8C, Supplementary Table S6C)

The sensitivity analysis using the poverty line to define impoverishment showed a similar trend. (Supplementary Table S6A-C) HD patients in the poorest quintile still had the highest proportion of medical impoverishment in all health schemes.

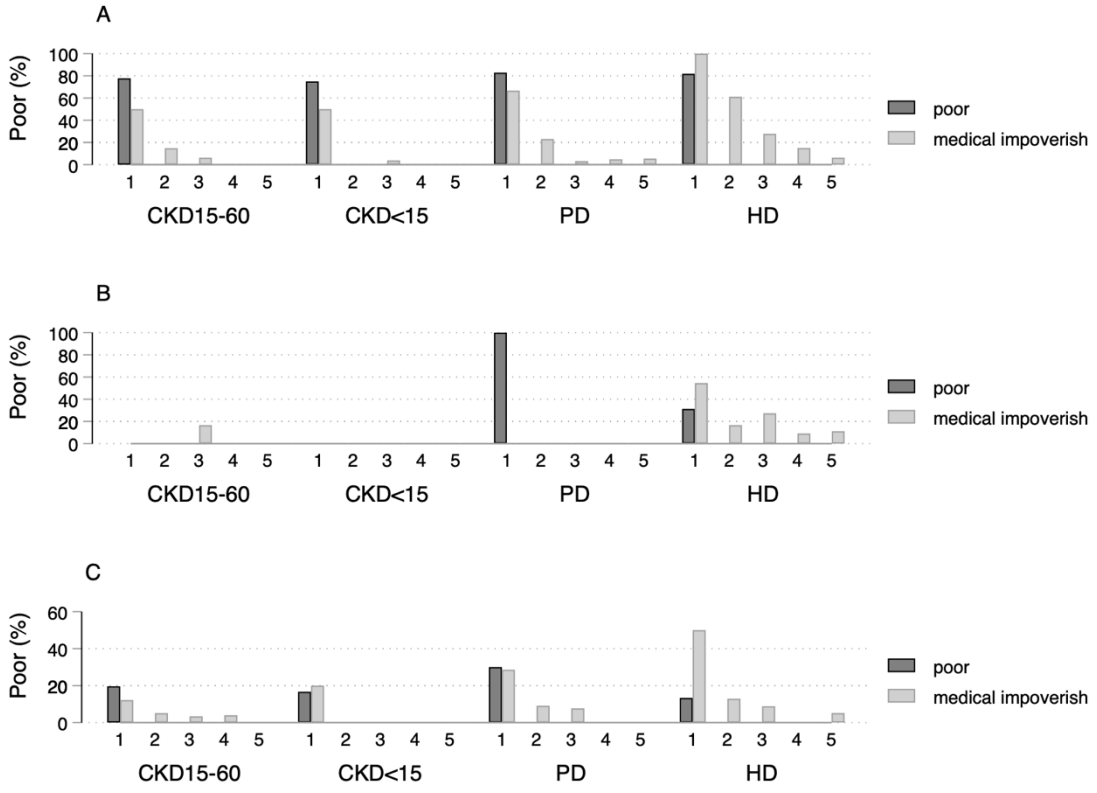

Figure 3.8 Socioeconomic status quintiles-specific proportion of pre-out-of-pocket (pre-OOP)[a] and medical impoverishment.[b] A) UCS; B) SSS; C) CSMBS

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure

[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

3.7 Determinants of CHE

We analyzed the factors that determine CHE using multivariable logistic regression. Table 3.4 provides the multivariable logistic regression results. Compared with CKD15-60, PD and HD significantly increased the adjusted risk of CHE by 3.3 and 8.8 folds, respectively. Dialysis treatment, especially HD, was the significant determinant of incurring CHE. Health schemes themselves were not the significant risk of developing CHE.

After the inclusion of the interaction between health schemes and CKD groups into the model, CHE40 risk in UCS on PD and HD increased by 3.5 and 16.3 folds, respectively. A similar pattern was seen for CSMBS, whereas PD had a greater risk of CHE in SSS than HD.

Other significant risk factors for CHE were older age, cardiovascular disease, absence of hypertension, and low numbers of household members. Increasing age (adjusted OR = 1.027, 95%CI: 1.013-1.019) and cardiovascular disease (adjusted OR = 1.767, 95% CI:1.147-1.829) significantly increased the risk of CHE while household size (adjusted OR =0.806, 95 %CI: 0.718-0.863) significantly associated with a decrease in the risk of incurring CHE. (Supplementary Table S7A, B)

Table 3.4 multivariable adjusted factors affecting CHE.

Covariates (reference)	**CHE40** [a]			**CHE10** [b]		
	AOR [c]	**95% CI**	**P value**	**AOR** [c]	**95% CI**	**P value**
Health insurance schemes (UCS)						
SSS	0.947	0.446-2.009	0.886	1.262	0.808-1.971	0.306
CSMBS	0.903	0.590-1.381	0.636	1.180	0.963-1.446	0.111
CKD groups (CKD15-60)						
CKD<15	0.709	0.371-1.355	0.298	1.525	1.017-2.285	**0.041**
PD	3.321	2.072-5.322	< **0.001**	4.459	2.332-8.528	< **0.001**
HD	8.828	5.295-14.718	< **0.001**	11.084	8.073-15.218	< **0.001**
Interaction between health insurance schemes and CKD (UCS, CKD15-60)						
UCS, CKD<15	1.188	0.691-2.042	0.534	1.324	0.860-2.039	0.202
UCS, PD	3.533	1.598-7.813	**0.002**	4.584	1.961-10.714	< **0.001**

Covariates (reference)	CHE40 [a]			CHE10 [b]		
	AOR [c]	**95% CI**	**P value**	**AOR** [c]	**95% CI**	**P value**
UCS, HD	16.280	8.173-32.430	< **0.001**	14.390	8.671-23.883	< **0.001**
SSS, CKD15-60	1.724	0.278-10.693	0.559	0.712	0.144-3.515	0.677
SSS, CKD<15	NA			2.595	1.267-5.316	**0.009**
SSS, PD	21.153	5.856-76.406	< **0.001**	19.513	5.805-65.589	< **0.001**
SSS, HD	8.301	3.073-22.428	< **0.001**	12.286	6.507-23.198	< **0.001**
CSMBS, CKD15-60	1.314	0.778-2.220	0.307	1.284	0.909-1.815	0.156
CSMBS, CKD<15	0.619	0.232-1.651	0.338	2.114	1.091-4.097	**0.027**
CSMBS, PD	4.946	2.387-10.247	< **0.001**	4.577	1.884-11.120	**0.001**
CSMBS, HD	9.394	5.198-16.978	< **0.001**	12.679	7.663-20.978	< **0.001**

[a] The percentage of households in which out-of-pocket payments for health care was at least 40% of the household capacity to pay

[b] The percentage of households in which out-of-pocket payments for health care was 10% or more of households' total consumption expenditure

[c] Adjusted with age, sex, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members

AOR, adjusted odds ratio, NA cannot be calculated due to the small number of patients

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

As shown in Table 3.5 and Figure 3.9, the probability of CHE in UCS patients on HD was significantly higher than in PD. The adjusted likelihood of CHE under UCS was significantly higher in HD than in PD (53% vs. 22%, $p < 0.05$). For patients under SSS, the probability of CHE was highest among patients with PD. And for patients under CSMBS, the probability of CHE in HD was higher than in PD but not significant. For all health schemes, the risk of CHE was lower in CKD 15-60 and CKD< 15 than in dialysis groups. With the sensitivity analysis, we found a similar trend.

Table 3.5 Multivariable adjusted probability of Catastrophic Health Expenditure (CHE).

Variables	CHE40 [a,c]		CHE10 [b,c]	
	Adjusted Probability	95% CI	Adjusted Probability	95% CI
CKD15-60#UCS	0.076	0.042-0.109	0.149	0.116-0.183
CKD15-60#SSS	0.120	-0.013-0.252	0.112	-0.044-0.267
CKD15-60#CSMBS	0.096	0.059-0.134	0.183	0.130-0.236
CKD<15#UCS	0.088	0.052-0.125	0.187	0.126-0.248
CKD<15#SSS	.	.	0.306	0.159-0.453
CKD<15#CSMBS	0.049	0.003-0.094	0.266	0.142-0.390
PD#UCS	0.215	0.139-0.290	0.432	0.284-0.581
PD#SSS	0.582	0.319-0.845	0.753	0.547-0.959
PD#CSMBS	0.272	0.130-0.415	0.432	0.242-0.622
HD#UCS	0.527	0.366-0.687	0.694	0.588-0.800
HD#SSS	0.373	0.238-0.507	0.661	0.566-0.757
HD#CSMBS	0.403	0.284-0.522	0.668	0.588-0.748

[a]: The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay.

[b]: The percentage of households in which out-of-pocket payments for health care was 10% or more of households' total consumption expenditure

[c] Adjusted with age, sex, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

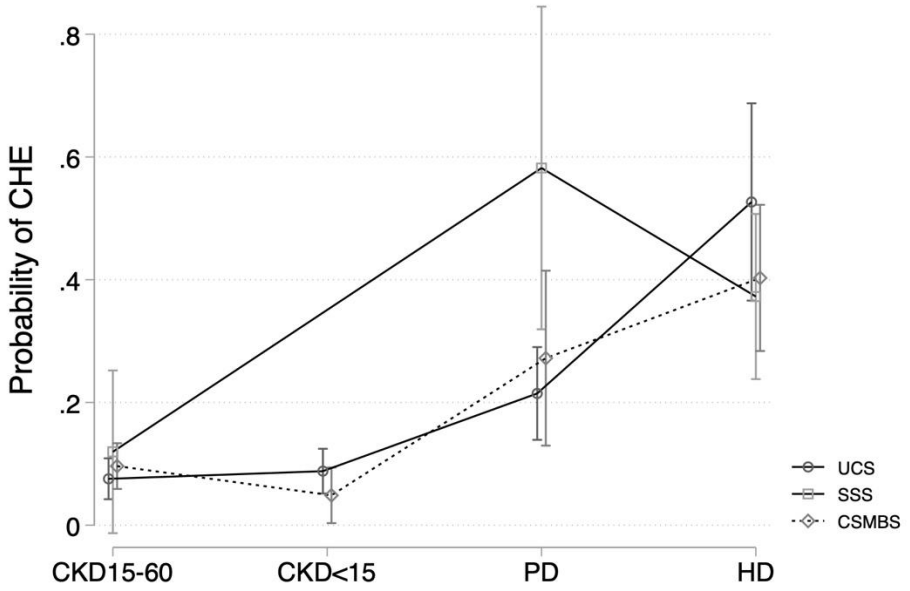

Figure 3.9 Adjusted Probability of Catastrophic Health Expenditure (CHE40)[a] by health insurance schemes and CKD groups.

[a] The percentage of households in which out-of-pocket payments for health care was at least 40% of the household capacity to pay

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

Adjusted with age, sex, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members

3.8 The probability of CHE by geographic regions

We also analyzed the effect of different regions on the probability of CHE. We found that the adjusted prevalence of CHE40 was higher in the Central compared to the North, East, and South regions, and the adjusted prevalence of CHE40 was higher in the Northeast compared to the North and East regions. The adjusted probability of CHE10 also showed a higher prevalence in the Central region. (Table 3.6)

Table 3.6 Probability of incurring Catastrophic Health Expenditure (CHE) by regions from the modeling

Variables	CHE40 [a,c]		CHE10 [b,c]	
	Average Probability	95% CI	Average Probability	95% CI
Regions				
Central	0.297	0.231- 0.363	0.434	0.366 - 0.502
North	0.150	0.114 - 0.185	0.304	0.260 - 0.348
Northeast	0.228	0.164 - 0.291	0.363	0.307 - 0.420
East	0.122	0.103 - 0.141	0.313	0.283 - 0.343
South	0.178	0.127 - 0.230	0.377	0.356 - 0.397

[a]: The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay.
[b]: The percentage of households in which out-of-pocket payments for health care was more than 10% of households' total consumption expenditure
[c] Adjusted with age, sex, CKD groups, health insurance scheme, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members
95% CI, 95% Confidence Interval

Chapter 4
Discussion

Even though Thailand has implemented universal coverage for CKD treatment, there is still residual financial hardship, particularly in poor HD patients. The incidence of CHE and medical impoverishment differed according to stages of CKD and health insurance schemes. HD suffered from CHE and medical impoverishment significantly higher than PD and non-dialysis patients in every health insurance scheme. The poorest HD patients under UCS incurred the highest CHE and medical impoverishment.

Non-dialysis patients suffered less CHE and medical impoverishment than dialysis patients across all quintiles of total household expenditures. The health status of non-dialysis CKD patients was generally better than dialysis patients with less frequent hospital visits. We found that both CKD 15-60 and CKD<15 spent out-of-pocket for medical and non-medical costs less than HD and PD, despite their total household expenditure not being significantly different from HD and PD groups. Therefore, the less OOP spending on health may be the reason to explain why non-dialysis CKD patients experienced less CHE and medical impoverishment. The study from Italy and Japan also found similar results that early stages of CKD spent less medical expenditure than late stages of CKD.[17,19] These results of our research and data from other studies emphasize that promoting interventions that can delay the progression toward the end stage of kidney disease would benefit financial protection for both patients and policymakers.

In Thailand, universal health coverage substantially reduces the financial burden of health care among the poor.[33,37] In the Thai population, the incidence of medical impoverishment (using the national poverty line) decreased from 2.3% in 1990 to 0.3% in 2015. CHE decreased from 7.1% to 2.1%.[36], which is significantly lower than the global proportion of 12%.[66] However, these reductions in financial burden from univeral health coverage policy were not specific to CKD patients.

Our study's overall incidence of CHE in PD and HD patients was 22.2 and 40.8 %, respectively, which was much lower than the reported prevalence of 95% from India.[83] The study by Waleekhachonioet O et al. in 2 tertiary hospitals in, Northeastern region of Thailand in 2017 showed that PD suffered from the financial burden more than HD. The median (IQR) of monthly OOP spending for health in 42 HD was 15,600 Thai Baht (2,000-36,000) which

was higher than 4,000 Thai Baht (2,400-6,000) in 46 PD patients. But PD patients had lower income, more debt, and suffered from financial burden more than HD. However, the financial burden from this study was from the interview on whether CKD affected patients' financial status.[113] In our study, HD spent out-of-pocket and incurred CHE and medical impoverishment more than PD. The difference in our results from this study may be because of using different measures of financial hardship. We calculated the incidence of CHE and medical impoverishment from OOP and household expenditure.

Table 4.1 Summary of studies reporting the prevalence of CHE

	Country	Year of study	Study population	Definition of CHE /financial burden	Outcomes
Shin SM, et al. [25]	Korea	2008 - 2013	305 End-stage renal disease patients	CHE = OOP for medications > 40% of capacity to pay	Prevalence of CHE: All NHI 62.1% All MA 58.8% NHI for less than the median of total household income decile 92.2%
Bassi A, et al. [119]	India	2014-2016	119 hemodialysis patients		The average OOP expenditure was 165% of family income. 95.4% of patients spent OOP > 40% of income on healthcare
Khan A, et al. [120]	North India	2015-2017	200 End stage renal disease patients	CHE = OOP > 25% of monthly household income	Prevalence of CHE 95%
Bradshaw C, et al. [26]	India	2018	835 hemodialysis patients	CHE = OOP expenditure > 40% of non-subsistence expenditure	Prevalence of CHE Government subsidy of 90% No government subsidy 93%

Table 4.1 summarizes the reported prevalence of CHE in other countries. The study from Korea by Shin SM et al. [25] showed that about 60% of ESKD patients incurred CHE. The studies from India reported 90-95% of hemodialysis patients suffered from CHE. [26,119,120]

Bradshaw C et al. defined CHE with the exact definition of our study.[26] Still, it included the costs of patients' and caregivers' work loss for out-of-pocket expenditures, which may explain the higher incidence of CHE than our study. These results emphasize the significant financial burden among ESKD patients, especially in developing countries.

HD patients need to travel to the dialysis center twice or thrice weekly. Traveling to hemodialysis centers will result in more direct non-medical OOP spending than PD and non-dialysis CKD. In our study, travel cost was the main contributor (44-49.3%) of total OOP spending for health care services in HD patients under every health insurance scheme. In the study from South India, direct medical care costs for hemodialysis account for 55% of the total cost. In contrast, direct non-medical costs, e.g.travel costs, account for around 20% of the total cost.[85] Senanayake SJ et al. reported travel contributed 42.7% of total OOP spending in Sri Lankan HD patients.[84] Studies from Sudan, China, and Taiwan found similar results: travel cost was higher in HD than in PD patients. (Table 4.2)

Table 4.2 Summary of studies reporting travel costs

	Country	**Study population**	**CKD-ND**	**PD**	**HD**
Senanayake SJ, et al [84]	Sri Lanka	38 HD			Transport 42.7%
Yousif AO, et al. [86]	Sudan	130 HD			Transport 14%
Wu H, et al [62]	China	108 HD, 91 PD		30.0±27.08	61.9±95.98
Aoun, et al. [121]	Lebanon	102 non-dialysis CKD (CKD-ND) 8 PD 40 HD	Median (IQR) 40,000 (20,000-60,000)	Median (IQR) 80,000 (52,500-137,500)	Median (IQR) 720,000 (720,000-720,000)
Tang CH, et al. [122]	Taiwan	246 PD 308 HD		Median (IQR) 143 (16-293)	Median (IQR) 293 (0-1495)

In our study, compared with PD, HD pushed patients into CHE and medical impoverishment across all socioeconomic statuses, with the worst among the poorest. Our study's incidence of CHE in PD and HD patients was 22.2% and 40.8%, respectively. This result reflects that PD should be a preferable dialysis modality to HD, especially for the poor,

and also supports PD First policy in terms of financial protection. Furthermore, PD is cheaper and more sustainable than HD. PD is a home-based treatment that needs lower travel time and costs and increased patient autonomy, satisfaction, and better quality of life than HD. PD also offers a flexible schedule and maintains the ability to work and travel. In addition, PD needs less budget to set up a dialysis unit, and more cost-effective and sustainable than HD.[107] Many rural hospitals have successfully implemented PD services for patients living in remote areas, so patients can do dialysis at home without frequently traveling to healthcare facilities.[90] However, the median time to transferring to HD among PD patients under the Thai' PD First policy' reported by Sangthawan P et al. was only 18.5 (95% CI 17.8-19.3) months.[123] Therefore, policymakers should consider the interventions which can potentially prolong PD vintage, such as Automated Peritoneal dialysis (APD).[124] Thai government recently included APD in the UCS benefit scheme. This strategy would benefit PD patients in terms of health status as well as financial protection.

However, there were still patients who needed to be on HD. From our study, HD patients suffered from CHE and medical impoverishment more than other CKD groups despite universal coverage. The main contributor to CHE and medical impoverishment was travel costs. The policymakers could use this information to consider additional benefits and geographical distribution of medical services and health personnel for HD patients.

From our analysis, patients under SSS who were on PD suffered CHE more than other health schemes. The SSS provided a benefits package for dialysis through capitation, and the copayment for PD was higher than HD. Our study found that SSS patients on PD spent out-of-pocket on medications and medical treatment higher than HD but less on non-medical costs. The total OOP spending was not different between PD and HD patients. Total household expenditure in PD was slightly higher than in HD. However, there were only 4 SSS patients on PD who incurred CHE; therefore, the number was too small to conclude.

We observed that older age and cardiovascular disease were significantly associated with a higher incidence of CHE. In addition, the elderly and comorbidity were associated with more frequent medical visits and medicines. We also found that a large household size was associated with a lower incidence of CHE. The explanation might be because large households might have more than one earning family member and consequently a higher total household income and expenditure. CKD patients from the Central region incurred the

highest probability of developing CHE, and this may be because of the higher living cost in the Central region.

Strengths and limitations of the study

There were limitations in our study. Firstly, using a cross-sectional survey does not capture the fluctuation of expenditures throughout the year. Secondly, the study results were obtained based on a questionnaire via the interview, which was subjected to recall bias and bias due to the infrequency of consumption. In this study, we minimized these limitations by collecting the expenses during the past six months and asking family members or caregivers to ascertain the interview data.

This study's strength is the first to compare the proportion of CHE and impoverishment from OOP expenditures among health schemes and different levels of chronic kidney disease patients in Thailand. The data collection was performed through direct patient interviews. We collected direct non-medical costs such as food, transportation, and accommodation as well as costs for medical equipment or health improvement and formal caregiver. The results of this study would reflect the overall financial burden of CKD from the patients' and families' perspectives. This study provides insights into the economic impact of total OOP spending on CKD households in Thailand. Another strength of this study is the nearly equal distribution of participants from all regions of Thailand. We collected the data from both university and non-university hospitals, which are the hospitals where nephrologists provide both HD and PD treatment. Therefore, the results of this study could represent the costs among CKD patients under three healthcare schemes in Thailand.

Chapter 5
Conclusion

This study makes an essential contribution to the cost of CKD care by improving the understanding of the economic circumstance of households affected by CKD among different healthcare schemes under universal coverage in Thailand. Despite Thailand's comprehensive social health insurance system, we found high levels of CHE and medical impoverishment among dialysis. Based on our findings, patients receiving HD suffered CHE the most, even though they needed to use it. PD is a preferable dialysis modality to HD due to less CHE and impoverishment. The extent of CHE and medical impoverishment was also highest among the poorest. The protection of these disadvantaged groups, especially HD patients, is the area that policymakers should focus on and consider strategies to minimize any potentially inequitable effect on their financial status. Since February 2022, the Thai government has changed the dialysis policy from PD First to Shared Decision Making. As a result, there are more ESRD patients entering HD treatment. Therefore, there should be a follow-up study on the financial burden among dialysis patients due to policy change.

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Appendices

Appendix A

Case record form

Part A: CKD History

1. **เพศ** ❑ 1. ชาย ❑ 2. หญิง

2. **ปี พ.ศ. เกิด** □□□□ อายุ □□ ปี

3. สิทธิการรักษาหลัก ในปัจจุบัน

□1. ประกันสุขภาพแห่งชาติ □□2. ประกันสังคม □□3. เบิกข้าราชการ □□

□4. ประกันสุขภาพเอกชน □□5. จ่ายเอง □□6. สวัสดิการพนักงานรัฐวิสาหกิจ □7. กองทุน/สวัสดิการชุมชน

4. Serum creatinine (ปัจจุบัน)

4.1. วันที่ตรวจ □□/□□/25□□ ค่า **creatinine** □□.□□ **mg/dl**

❑ ไม่มีข้อมูล

4.**2**. e-GFR (CKD-EPI) □ □□□. □ ml/min/1.73m2

5. Duration of CKD or dialysis □□□ เดือน

6. Type of vascular access ปัจจุบัน (สำหรับผู้ป่วย hemodialysis)

❑1. AV fistula ❑2. AV graft ❑3. Tunnelled-cuffed catheter

❑4. Temporary catheter

7. Type of PD ปัจจุบัน (สำหรับผู้ป่วย Peritoneal Dialysis)

❑1. CAPD ❑2. Automate ❑3. อื่น ๆ โปรดระบุ _____

Part B: Risk Factor

7. โรคร่วม (co-morbid) ทั้งในอดีตและปัจจุบัน (ตอบได้มากกว่า 1 ข้อ)

❑ 1. Impaired fasting glucose ❑ 2. Diabetes type 1 ❑ 3. Diabetes type 2

❑ 4. Hypertension ❑ 5. Dyslipidaemia ❑ 6. COPD

❑ 7. Asthma ❑ 8. Parkinsonism ❑ 9. Hyperthyroid

❑ 10. Hypothyroid ❑ 11. Gastric/ peptic ulcer ❑ 12. Symptomatic gout

❑ 13. Thalassemia trait ❑ 14. Hepatitis B ❑ 15. Depression

❑16. Anxiety ❑ 17. Alzheimer's ❑ 18. Hemiplegia

❑ 19. Severe joint disease (joint replacement, decreased mobility, regular orthopaedic surgeon visit)

❑ 20. Skin ulcers/ cellulitis ❑ 21. Neuropathy ❑ 22. Amputation

❑ 23. Underlying CVD

23.1 ❑ AF

23.2 ❑Non-fatal myocardial infarction (MI)

❑ 1. ใช่ ❑ 2. ไม่ใช่ ❑ 3. ไม่มีข้อมูล

23.3. PCI (ภายใน 1 ปี)

❑ 1. ใช่ ❑ 2. ไม่ใช่ ❑ 3. ไม่มีข้อมูล

23.4. CABG (ภายใน 1 ปี)

❑ 1. ใช่ ❑ 2. ไม่ใช่ ❑ 3. ไม่มีข้อมูล

❑ 24. Non-fatal stroke

❑ 1. ใช่ ❑ 2. ไม่ใช่ ❑ 3. ไม่มีข้อมูล

❑ 25. AICD (Automatic implantable cardioverter defibrillator)

❑ 1. ใช่ ❑ 2. ไม่ใช่ ❑ 3. ไม่มีข้อมูล

❑ 26. Retinopathy

26.1. First diagnosis □□/□□/25□□ หรือ ❑ ไม่ทราบวันที่

26.2. Laser treated ❑ 1. มี ❑ 2. ไม่มี ❑ 3. ไม่มีข้อมูล

❑ 27. Blind

❑ 28. Cirrhosis

❑ 1. mild

❑ 2. moderate to severe (ascites, portal hypertension)

❑ 29. Malignancy ❑ 1. Solid tumours type _____ ❑ 2. Leukemia ❑ 3. Lymphoma

29.1. Year of first diagnosis □□□□

29.2. Status ❑1. Remission ❑2. Active on chemotherapy ❑ 3. Active no chemotherapy

29.3. Metastasis ❑ 1. มี ❑ 2. ไม่มี ❑3. ไม่มีข้อมูล

❑ 30. HIV/ AIDS

❑1. มีอาการ

❑ 1.1. มีอาการมานาน <12 เดือน ❑ 1.2. มีอาการมานาน >12 เดือน

❑ 2. ไม่มีอาการ

❑ 31. อื่นๆ ระบุ _____

Health Economic	Visit date ☐☐/☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐

Part health economic evaluation

1.monthly patient income

❑ 1. income ☐☐☐☐☐☐ baht/month ❑ 2. no income

2. number of family members and income

2.1. total family member (including patient) ☐☐

2.2. familial income ☐☐☐☐☐☐ baht/month

3. household expenditure

3.1. expense for food

3.1.1. food expense (whole family) ☐☐☐☐ baht/day

3.1.2. average food expense (whole family) ☐☐☐☐☐ baht/month

☐☐ % of total monthly household spending

3.2. total household spending (included cost for daily travel, electricity and water, clothes, tax, donation, not included cigarette, food)

average household spending ☐☐☐☐☐ baht/month

4.Data regarding out-of-pocket spending at OPD visit at study hospital during the past 6 months (including visit for dialysis, procedure)

1. How many visits at OPD during the past 6 months (including this visit)?	☐☐ times
2.How much money did patients pay out-of-pocket for health (cannot reimburse) at OPD visit this hospital during the past 6 months?	☐☐☐☐ baht
3. How many relatives or unpaid caregivers accompany patients for OPD visit?	☐☐ (patient come alone =0)
4. How many hours do patients spend for OPD visit ? (including time for travelling and waiting)	☐☐☐ hours/visit
5. How much extra-money (from routine daily spending for food) has been paid for food for both patients and caregivers on OPD visit day?	☐☐☐☐ baht/visit

Health Economic	Visit date ☐☐/☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐
6. How much of the average cost for the travelling on each OPD visit? (including fuel, public transport, for both patient and caregiver)	☐☐☐☐ baht/visit
7. How much money was paid for accommodation on OPD visit?	☐☐☐☐ baht/visit (no cost =0)
5. Data regarding out-of-pocket spending at OPD visit at other hospitals during the past 6 months (including visit for dialysis, procedure)	
1. How many visits at OPD during the past 6 months (including this visit)?	☐☐ times
2.How much money did patients pay out-of-pocket for health (cannot reimburse) at OPD visit other hospitals during the past 6 months?	☐☐☐☐☐ baht
3. How many relatives or unpaid caregivers accompany patients for OPD visit?	☐☐ (patient come alone =0)
4. How many hours do patients spend for OPD visit ? (including time for travelling and waiting)	☐☐☐ hours/visit
5. How much extra-money (from routine daily spending for food) has been paid for food for both patients and caregivers on OPD visit day?	☐☐☐ baht/visit
6. How much of the average cost for the travelling on each OPD visit? (including fuel, public transport, for both patient and caregiver)	☐☐☐☐☐ baht/visit
7. How much money was paid for accommodation on OPD visit?	☐☐☐☐ baht/visit (no cost =0)
6. Data regarding out-of-pocket spending at IPD admissions at both study and other hospitals during the past 6 months	
1. How many hospital admissions are there during the past 6 months?	❑ 1. yes ☐☐☐ times ❑ 2. no
2. How many admission days have patient spent in	☐☐☐ days

Health Economic	Visit date ☐☐/☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐
hospital during the past 6 months?	
3.How much money did patients pay out-of-pocket for health (cannot reimburse) at IPD admissions during the past 6 months?	☐☐☐☐ baht
4.How many relatives or unpaid caregivers take care of patients for IPD admission during the past 6 months?	☐☐☐ days ☐☐☐ hours/day
5. How much extra-money (from routine daily spending for food) has been paid for food for both patients and caregivers during IPD admission?	☐☐☐☐ baht/day
6. How much of the average cost for the travelling on each IPD admission? (including fuel, public transport, for both patient and caregiver)	☐☐☐☐☐ baht/visit
7.data regarding house improvement and buying equipment for health	
1. Is there any house improvement or buying equipment for health for CKD during the past 6 months?	❑ 1. yes ☐☐ times ❑ 2. no
2.How much money has been paid for equipment for health (such as special bed, wheelchair, etc) during the past 6 months?	☐☐☐☐☐ baht
3.How much money has been paid for house improvement for health during the past 6 months?	☐☐☐☐☐ baht
4.How much money has been paid for other things or facility to improve CKD status during the past 6 months?	☐☐☐☐☐ baht
8.data regarding caregiver during the past 6 months	
1. Does patient need paid caregiver at home?	❑ 1. yes ❑ 2. no
2. if need paid caregiver, how many does patient hire and how much money paid per month?	Number of paid caregiver ☐☐ cost of paid caregiver ☐☐☐☐☐☐ baht/month

Health Economic	Visit date ☐☐/☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐

9.data regarding out of hospital spending for medical cost during the past 6 months	
1. Did patient seek medical treatment outside hospitals?	❑ 1.no ❑ 2. yes
2. How much money has patient paid for medicine from drugstore?	☐☐☐☐☐ baht
3. How much money has patient paid for herb?	☐☐☐☐☐ baht
4. How much money has patient paid for supplement?	☐☐☐☐☐ baht
5. How much money has patient paid for other treatment outside hospital?	☐☐☐☐☐ baht

Interviewer ..... ☐-☐	date/month/year ☐☐/☐☐/25☐☐

Appendix B

The ethical committee approval

AF/17-03/01.1

คณะแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์

หนังสือฉบับนี้ให้ไว้เพื่อแสดงว่า

รหัสโครงการ: REC: 57-277-19-1

CREC No. CREC 005/57

ชื่อโครงการ (ภาษาไทย): การติดตามผู้ป่วยโรคไตเรื้อรังที่มีความเสี่ยงสูงต่อการเกิดโรคหัวใจและโรคหลอดเลือดหรือการเสื่อมของการทำงานของไตแบบสหสถาบัน (ส.ห.ส.)

ชื่อโครงการ (ภาษาอังกฤษ): A cohort of CKD patients with high risk for cardiovascular events or renal disease progression multicenter study (CORE-CKD Thailand

ผู้วิจัยหลัก: รศ.มล.นพ.ชาครีย์ กิติยากร **สังกัด:** คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

ผู้วิจัยหลัก มอ. ผศ.พญ.พรเพ็ญ แสงฉวัลย์ **สังกัด:** คณะแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์

เอกสารที่รับรอง:

1. แบบเสนอเพื่อขอรับการพิจารณาจริยธรรมการวิจัยในมนุษย์ เวอร์ชั่น 2.0 ฉบับลงวันที่ 2 สิงหาคม 2557
2. โครงการวิจัยฉบับสมบูรณ์ เวอร์ชั่น 2.0 ฉบับลงวันที่ 2 สิงหาคม 2557
3. เอกสารชี้แจงอาสาสมัคร เวอร์ชั่น 2.0 ฉบับลงวันที่ 2 สิงหาคม 2557
4. เอกสารแสดงเจตนายินยอมของอาสาสมัคร เวอร์ชั่น 2.0 ฉบับลงวันที่ 2 สิงหาคม 2557
5. แบบบันทึกข้อมูล
6. ประวัติผู้วิจัย

ได้ผ่านการรับรองจากคณะกรรมการจริยธรรมการวิจัยในมนุษย์คณะแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ โดยยึดหลักเกณฑ์ตามประกาศ เฮลซิงกิ (Declaration of Helsinki) และแนวทางการปฏิบัติการวิจัยทางคลินิกที่ดี (The International Conference on Harmonization in Good Clinical Practice หรือ ICH-GCP) โดยขอให้รายงานความก้าวหน้าของโครงการวิจัยทุก 12 เดือน

ลงชื่อ.....

(รองศาสตราจารย์นายแพทย์บุญสิน ตั้งตระกูลวนิช)

ประธานคณะกรรมการพิจารณาจริยธรรมการวิจัยในมนุษย์

วันที่รับรอง: 28 พฤศจิกายน 2557

วันหมดอายุ: 27 พฤศจิกายน 2558

สำนักงานจริยธรรมการวิจัยในมนุษย์
คณะแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์
15 ถ.กาญจนวานิช อ.หาดใหญ่ จ.สงขลา 90110
โทรศัพท์ 0-7445-1149, 0-7445-1157
โทรสาร 0-7421-2900

Appendix C
Supplementary materials

Supplementary Table S1 Out-of-pocket expenditure as the percentage of total out-of-pocket expenditures for health.

CKD groups	**CKD15-60(%)**			**CKD<15(%)**			**PD(%)**			**HD(%)**		
Health insurance schemes	**UCS**	**SSS**	**CSMBS**	**UCS**	**SSS**	**CSMBS**	**UCS**	**SSS**	**CSMBS**	**UCS**	**SSS**	**CSMBS**
Out-of-pocket for medical costs	36.9	9.8	35.7	28.5	50.8	37.0	42.8	42.3	30.6	34.8	34.4	20.1
Out-of-pocket for medical costs at OPD study hospital	11.3	0.0	7.9	10.1	28.6	13.4	30.7	20.7	19.4	9.8	12.1	7.3
Out-of-pocket for medical costs at OPD other hospital	2.7	0.0	8.2	1.4	6.1	4.2	0.7	5.4	1.7	23.3	12.3	3.6
Out-of-pocket for medical costs at IPD	11.7	0.0	8.8	13.9	11.5	6.7	3.4	3.7	1.0	0.6	7.8	4.5
Out-of-pocket for medical costs outside Hospital	11.2	9.8	10.8	3.2	4.6	12.7	8.0	12.5	8.5	1.1	2.2	4.7
Out-of-pocket for non-medical costs	63.1	90.2	64.3	71.5	49.2	63.0	57.2	57.7	69.4	65.2	65.6	79.9
Food cost at OPD study hospital	4.7	1.7	2.4	4.1	3.4	2.6	2.7	2.2	2.7	2.4	3.3	7.7
Food cost at OPD other hospital	0.3	0.0	0.2	0.3	0.4	0.2	0.2	0.1	0.0	2.7	2.3	1.6
Food cost at IPD	2.5	0.0	1.5	1.3	5.0	0.7	1.0	0.0	1.0	0.4	0.2	0.2
Travel cost at OPD study hospital	25.7	7.5	22.3	33.7	18.3	32.0	22.7	7.7	21.8	26.7	28.5	32.1
Travel cost at OPD other hospital	4.7	0.2	1.8	1.2	20.2	3.5	4.3	6.9	0.5	21.3	18.0	11.5
Travel cost at IPD	4.2	0.6	0.9	7.1	1.9	2.4	2.0	0.0	0.6	1.3	0.6	0.4
Accommodation cost OPD study hospital	0.2	0.0	0.7	0.0	0.0	4.5	1.7	0.0	2.3	0.0	0.0	0.9
Accommodation cost OPD other hospital	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	0.0
House improvement	11.9	62.8	21.1	16.8	0.0	14.1	12.5	10.1	23.4	0.2	10.0	6.6

Formal caregiver	8.9	17.4	13.4	6.9	0.0	3.0	10.1	30.3	17.1	10.2	2.5	18.9

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme, OPD outpatient department, IPD inpatient department

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

Supplementary Table S2 Proportion of Catastrophic Health Expenditure (CHE10) and impoverishment using poverty line by CKD groups.

	Total (95% CI)	**CKD15-60** (95% CI)	**CKD<15** (95% CI)	**PD** (95% CI)	**HD** (95% CI)	**P-value**
CHE10 [a]						
UCS	33.9% (29.9-37.9)	15.7% (9.9-21.4)	19.4% (12.0-26.9)	40.5%*$ (33.5-47.6)	67.0%*$ # (57.5-76.5)	**< 0.001**
SSS	46.8% (37.4-56.2)	8.3% (-2.7-19.4)	26.7% (4.3-49.0)	72.7%*$ (46.4-99.0)	62.7% *$ (50.4-75.1)	**< 0.001**
CSMBS	37.2% (33.3-41.2)	19.8% (14.9-24.6)	28.9% (19.5-38.3)	42.6%*$ (30.2-55.0)	66.9%*$ # (59.7-74.0)	**< 0.001**
Medical impoverishment						
UCS						
Pre-out-of-pocket impoverishment [b]	1.9% (0.7-3.0)	1.3% (-0.5-3.1)	0.9% (-0.9-2.7)	2.2% (0.1-4.3)	3.2% (-0.4-6.7)	0.643
Medical impoverishment [c]	6.9% (4.7-9.0)	4.6% (1.3-7.9)	3.7% (0.1-7.3)	3.8%$ (1.0-6.5)	20.2% *$ # (12.1-28.3)	**< 0.001**
SSS						
Pre-out-of-pocket impoverishment [b]	0.9% (-0.9-2.7)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	1.7% (-1.6-5.0)	1.000
Medical impoverishment [c]	6.4% (1.8-11.0)	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	10.2% (2.5-17.9)	0.591
CSMBS						
Pre-out-of-pocket impoverishment [b]	0.5%	0.8%	1.1%	0.0%	0.0%	0.591

	(-0.1-1.1)	(-0.3-1.8)	(-1.1-3.3)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [c]	3.1%	2.3%	0.0%	3.3%	6.0%*$ #	0.038
	(1.7-4.6)	(0.5-4.2)	(0.0-0.0)	(-1.2-7.7)	(2.4-9.6)	

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

[b]:The percentage of households in which total household expenditure was less than poverty line

[c]:The percentage of households in which total household expenditure after paying OOP for health, was less than poverty line,*P-value <0.05 vs CKD15-60, $ P-value <0.05 vs CKD<15, # P-value <0.05 vs PD

Supplementary Table S3 Socioeconomic status quintiles-specific proportion of Catastrophic Health Expenditure by CKD groups.

Characters	Quintiles of total household expenditure				
	1	**2**	**3**	**4**	**5**
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
CKD15-60					
n (%)	82 (18.9)	77 (17.7)	102 (23.4)	91 (20.9)	83 (19.1)
CHE40 [a]	20.7 (12.0; 29.5)	9.1 (2.7; 15.5)	10.8 (4.8; 16.8)	6.6 (1.5; 11.7)	2.4 (-0.9; 5.7)
CHE10 [b]	34.1 (23.9; 44.4)	15.6 (7.5; 23.7)	19.6 (11.9; 27.3)	13.2 (6.2; 20.1)	6.0 (0.9; 11.1)
CKD<15					
n (%)	43 (20.2)	48 (22.5)	41 (19.2)	34 (16.0)	47 (22.1)
CHE40 [a]	20.9 (8.8; 33.1)	4.2 (-1.5; 9.8)	2.4 (-2.3; 7.2)	0.0 (0.0; 0.0)	6.4 (-0.6; 13.4)
CHE10 [b]	30.2 (16.5; 44.0)	27.1 (14.5; 39.7)	14.6 (3.8; 25.5)	20.6 (7.0; 34.2)	25.5 (13.1; 38.0)
PD					
n (%)	63 (24.5)	56 (21.8)	42 (16.3)	49 (19.1)	47 (18.3)
CHE40 [a]	33.3 (21.7; 45.0)	21.4 (10.7; 32.2)	26.2 (12.9; 39.5)	20.4 (9.1; 31.7)	6.4 (-0.6; 13.4)
CHE10 [b]	50.8 (38.4; 63.1)	37.5 (24.8; 50.2)	47.6 (32.5; 62.7)	42.9 (29.0; 56.7)	31.9 (18.6; 45.2)
HD					
n (%)	57 (17.9)	64 (20.1)	60 (18.8)	71 (22.3)	67 (21.0)
CHE40[a]	75.4 (64.3; 86.6)	51.6 (39.3; 63.8)	38.3 (26.0; 50.6)	26.8 (16.5; 37.1)	17.9 (8.7; 27.1)

CHE10[b]	84.2 (74.7; 93.7)	64.1 (52.3; 75.8)	68.3 (56.6; 80.1)	59.2 (47.7; 70.6)	58.2 (46.4; 70.0)

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[b]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

Supplementary Table S4 Socioeconomic status quintiles-specific proportion of Catastrophic Health Expenditure (CHE).
Supplementary Table S4A Socioeconomic status quintiles-specific proportion of CHE in UCS.

Quintiles of socioeconomic status	Total	1	2	3	4	5	P-value
	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	
CKD15-60 (N=153)							
CHE40 [a]	8.5%	19.4%	11.1%	6.2%	3.1%	0.0%	0.051
	(4.1-12.9)	(6.5-32.4)	(-0.7; 23.0)	(-2.1-14.6)	(-2.9-9.2)	(0.0-0.0)	
CHE10 [b]	15.7%	33.3%	22.2%	12.5%	6.2%	0.0%	**0.002**
	(9.9-21.4)	(17.9-48.7)	(6.5-37.9)	(1.0-24.0)	(-2.1-14.6)	(0.0-0.0)	
CKD<15 (N=108)							
CHE40 [a]	9.3%	31.2%	4.3%	7.7%	0.0%	6.9%	0.047
	(3.8-14.7)	(8.5-54.0)	(-4.0; 12.7)	(-2.6-17.9)	(0.0-0.0)	(-2.3-16.1)	
CHE10 [b]	19.4%	31.2%	17.4%	23.1%	0.0%	20.7%	0.230
	(12.0-26.9)	(8.5-54.0)	(1.9-32.9)	(6.9-39.3)	(0.0-0.0)	(5.9-35.4)	
PD (N=185)							
CHE40 [a]	19.5%	31.4%	25.6%	12.5%	14.3%	13.5%	0.176
	(13.8-25.2)	(16.0-46.8)	(11.9-39.3)	(1.0-24.0)	(3.7-24.9)	(2.5-24.5)	
CHE10 [b]	40.5%	51.4%	41.0%	28.1%	45.2%	35.1%	0.336
	(33.5-47.6)	(34.9-68.0)	(25.6-56.5)	(12.5-43.7)	(30.2-60.3)	(19.8-50.5)	
HD (N=94)							
CHE40 [a]	50.0%	81.8%	66.7%	50.0%	25.0%	18.8%	**<0.001**
	(39.9-60.1)	(65.7-97.9)	(44.9-88.4)	(26.9-73.1)	(6.0-44.0)	(-0.4-37.9)	
CHE10 [b]	67.0%	90.9%	72.2%	61.1%	60.0%	43.8%	**0.024**
	(57.5-76.5)	(78.9-102.9)	(51.5-92.9)	(38.6-83.6)	(38.5-81.5)	(19.4-68.1)	

UCS, Universal Coverage Scheme, CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[b]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

Supplementary Table S4B Socioeconomic status quintiles-specific proportion of CHE in SSS.

Quintiles of socioeconomic status	Total (95% CI)	1 (95% CI)	2 (95% CI)	3 (95% CI)	4 (95% CI)	5 (95% CI)	P-value
CKD15-60 (N=24)							
CHE40 [a]	8.3%	0.0%	0.0%	16.7%	14.3%	0.0%	1.000
	(-2.7-19.4)	(0.0- 0.0)	(0.0-0.0)	(-13.2-46.5)	(-11.6-40.2)	(0.0-0.0)	
CHE10 [b]	8.3%	0.0%	0.0%	16.7%	14.3%	0.0%	1.000
	(-2.7-19.4)	(0.0-0.0)	(0.0-0.0)	(-13.2- 46.5)	(-11.6-40.2)	(0.0-0.0)	
CKD<15 (N=15)							
CHE40 [a]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
CHE10 [b]	26.7%	0.0%	50.0%	25.0%	0.0%	33.3%	0.859
	(4.3-49.0)	(0.0-0.0)	(1.0-99.0)	(-17.4-67.4)	(0.0-0.0)	(-20.0-86.7)	
PD (N=11)							
CHE40 [a]	54.5%	100.0%	66.7%	100.0%	50.0%	25.0%	0.766
	(25.1-84.0)	(100.0-100.0)	(13.3-120.0)	(100.0-100.0)	(-19.31-19.3)	(-17.4-67.4)	
CHE10 [b]	72.7%	100.0%	100.0%	100.0%	50.0%	50.0%	0.745
	(46.4-99.0)	(100.0-100.0)	(100.0-100.0)	(100.0-100.0)	(-19.3-119.3)	(1.0-99.0)	
HD (N=59)							
CHE40 [a]	32.2%	62.5%	25.0%	27.3%	9.1%	22.2%	**0.046**
	(20.3-44.1)	(38.8-86.2)	(0.5-49.5)	(1.0-53.6)	(-7.9-26.1)	(-4.9-49.4)	
CHE10 [b]	62.7%	81.2%	50.0%	72.7%	36.4%	66.7%	0.144
	(50.4-75.1)	(62.1-100.4)	(21.7-78.3)	(46.4-99.0)	(7.9-64.8)	(35.9-97.5)	

SSS, Social Security System

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[b]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

Supplementary Table S4C Socioeconomic status quintiles-specific proportion of CHE in CSMBS.

Quintiles of socioeconomic Status	Total (95% CI)	1 (95% CI)	2 (95% CI)	3 (95% CI)	4 (95% CI)	5 (95% CI)	P-value
CKD15-60 (N=258)							
CHE40 [a]	10.9%	17.6%	20.3%	5.1%	4.0%	5.1%	**0.010**
	(7.1-14.6)	(7.2-28.1)	(10.1-30.6)	(-0.5-10.7)	(-1.4-9.4)	(-1.8-12.1)	
CHE10 [b]	19.8%	29.4%	30.5%	16.9%	12.0%	5.1%	**0.004**
	(14.9-24.6)	(16.9-41.9)	(18.8-42.3)	(7.4-26.5)	(3.0-21.0)	(-1.8-12.1)	
CKD<15 (N=90)							
CHE40 [a]	5.6%	16.7%	0.0%	0.0%	6.2%	0.0%	0.079
	(0.8-10.3)	(1.8-31.6)	(0.0-0.0)	(0.0-0.0)	(-5.6-18.1)	(0.0-0.0)	
CHE10 [b]	28.9%	45.8%	21.4%	23.5%	18.8%	26.3%	0.360
	(19.5-38.3)	(25.9-65.8)	(-0.1-42.9)	(3.4-43.7)	(-0.4-37.9)	(6.5-46.1)	
PD (N=61)							
CHE40 [a]	24.6%	70.0%	36.4%	23.1%	0.0%	5.6%	**0.001**
	(13.8-35.4)	(41.6-98.4)	(7.9-64.8)	(0.2-46.0)	(0.0-0.0)	(-5.0-16.1)	
CHE10 [b]	42.6%	90.0%	45.5%	38.5%	0.0%	38.9%	**0.002**
	(30.2-55.0)	(71.4-108.6)	(16.0-74.9)	(12.0-64.9)	(0.0-0.0)	(16.4-61.4)	
HD (N=166)							
CHE40 [a]	38.6%	73.3%	48.4%	44.1%	18.8%	15.4%	**<0.001**
	(31.2-46.0)	(57.5-89.2)	(30.8-66.0)	(27.4-60.8)	(5.2-32.3)	(4.1-26.7)	
CHE10 [b]	66.9%	76.7%	71.0%	70.6%	56.2%	61.5%	0.440
	(59.7-74.0)	(61.5-91.8)	(55.0-86.9)	(55.3-85.9)	(39.1-73.4)	(46.3-76.8)	

CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[b]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

Supplementary Table S5 Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment by CKD groups.

Characters	**1** % (95% CI)	**2** % (95% CI)	**3** % (95% CI)	**4** % (95% CI)	**5** % (95% CI)
CKD15-60					
n (%)	82 (18.9)	77 (17.7)	102 (23.4)	91 (20.9)	83 (19.1)
Pre-out-of-pocket impoverishment [a]	46.3 (35.5; 57.1)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [b]	25.0 (12.2; 37.8)	6.5 (1.0; 12.0)	2.9 (-0.3; 6.2)	4.4 (0.2; 8.6)	0.0 (0.0; 0.0)
Pre-out-of-pocket impoverishment [c]	4.9 (0.2; 9.5)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [d]	7.3 (1.7; 13.0)	3.9 (-0.4; 8.2)	2.0 (-0.7; 4.7)	3.3 (-0.4; 7.0)	0.0 (0.0; 0.0)
CKD<15					
n (%)	43 (20.2)	48 (22.5)	41 (19.2)	34 (16.0)	47 (22.1)
Pre-out-of-pocket impoverishment [a]	37.2 (22.8; 51.7)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [b]	22.2 (6.5; 37.9)	2.1 (-2.0; 6.1)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Pre-out-of-pocket impoverishment [c]	4.7 (-1.6; 10.9)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [d]	7.0 (-0.6; 14.6)	2.1 (-2.0; 6.1)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
PD					
n (%)	63 (24.5)	56 (21.8)	42 (16.3)	49 (19.1)	47 (18.3)
Pre-out-of-pocket impoverishment [a]	52.4 (40.0; 64.7)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [b]	43.3 (25.6; 61.1)	5.4 (-0.5; 11.3)	4.8 (-1.7; 11.2)	6.1 (-0.6; 12.8)	2.1 (-2.0; 6.3)
Pre-out-of-pocket impoverishment [c]	6.3 (0.3; 12.4)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [d]	9.5 (2.3; 16.8)	0.0 (0.0; 0.0)	4.8 (-1.7; 11.2)	2.0 (-1.9; 6.0)	0.0 (0.0; 0.0)
HD					

n (%)	57 (17.9)	64 (20.1)	60 (18.8)	71 (22.3)	67 (21.0)
Pre-out-of-pocket impoverishment [a]	47.4 (34.4; 60.3)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [b]	73.3 (57.5; 89.2)	31.2 (19.9; 42.6)	11.7 (3.5; 19.8)	8.5 (2.0; 14.9)	6.0 (0.3; 11.6)
Pre-out-of-pocket impoverishment [c]	7.0 (0.4; 13.6)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Medical impoverishment [d]	26.3 (14.9; 37.7)	17.2 (7.9; 26.4)	5.0 (-0.5; 10.5)	4.2 (-0.5; 8.9)	4.5 (-0.5; 9.4)

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure

[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

[c]:the percentage of households in which total household expenditure was less than poverty line

[d]:the percentage of households in which total household expenditure after paying OOP for health, was less than poverty line

Supplementary Table S6 Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment.
Supplementary Table S6A Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment in UCS.

Quintiles of socioeconomic status	**Total**	**1**	**2**	**3**	**4**	**5**	**P-value**
	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	
CKD15-60 (N=153)							
Pre-out-of-pocket impoverishment [a]	18.3%	77.8%	0.0%	0.0%	0.0%	0.0%	< **0.001**
	(12.2- 24.4)	(64.2-91.4)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	8.0%	50.0%	14.8%	6.2%	0.0%	0.0%	< **0.001**
	(3.2-12.8)	(15.4-84.6)	(1.4-28.2)	(-2.1-14.6)	(0.0-0.0)	(0.0-0.0)	
Pre-out-of-pocket impoverishment [c]	1.3%	5.6%	0.0%	0.0%	0.0%	0.0%	0.198
	(-0.5-3.1)	(-1.9-13.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	4.6%	11.1%	3.7%	6.2%	0.0%	0.0%	0.161
	(1.3-7.9)	(0.8-21.4)	(-3.4-10.8)	(-2.1-14.6)	(0.0-0.0)	(0.0-0.0)	
CKD<15 (N=108)							
Pre-out-of-pocket impoverishment [a]	11.1%	75.0%	0.0%	0.0%	0.0%	0.0%	< **0.001**
	(5.2-17.0)	(53.8-96.2)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	3.1%	50.0%	0.0%	3.8%	0.0%	0.0%	**0.003**
	(-0.4-6.6)	(1.0-99.0)	(0.0-0.0)	(-3.5-11.2)	(0.0-0.0)	(0.0-0.0)	
Pre-out-of-pocket impoverishment [c]	0.9%	6.2%	0.0%	0.0%	0.0%	0.0%	0.278
	(-0.9-2.7)	(-5.6-18.1)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	3.7%	18.8%	0.0%	3.8%	0.0%	0.0%	**0.017**
	(0.1-7.3)	(-0.4-37.9)	(0.0-0.0)	(-3.5-11.2)	(0.0-0.0)	(0.0-0.0)	
PD (N=185)							
Pre-out-of-pocket impoverishment [a]	15.7%	82.9%	0.0%	0.0%	0.0%	0.0%	< **0.001**
	(10.4-20.9)	(70.4-95.3)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	11.5%	66.7%	23.1%	3.1%	4.8%	5.4%	< **0.001**
	(6.5-16.6)	(28.9-104.4)	(9.9-36.3)	(-2.9-9.2)	(-1.7-11.2)	(-1.9-12.7)	
Pre-out-of-pocket impoverishment [c]	2.2%	11.4%	0.0%	0.0%	0.0%	0.0%	**0.002**

Quintiles of socioeconomic status	**Total**	**1**	**2**	**3**	**4**	**5**	**P-value**
	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	
	(0.1-4.3)	(0.9-22.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	3.8%	14.3%	0.0%	0.0%	2.4%	2.7%	**0.011**
	(1.0-6.5)	(2.7-25.9)	(0.0-0.0)	(0.0-0.0)	(-2.2-7.0)	(-2.5-7.9)	
HD (N=94)							
Pre-out-of-pocket impoverishment [a]	19.1%	81.8%	0.0%	0.0%	0.0%	0.0%	< **0.001**
	(11.2- 27.1)	(65.7-97.9)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	31.6%	100.0%	61.1%	27.8%	15.0%	6.2%	< **0.001**
	(21.1- 42.0)	(100.0-100.0)	(38.6-83.6)	(7.1-48.5)	(-0.6-30.6)	(-5.6-18.1)	
Pre-out-of-pocket impoverishment [c]	3.2%	13.6%	0.0%	0.0%	0.0%	0.0%	**0.036**
	(-0.4-6.7)	(-0.7-28.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	20.2%	31.8%	33.3%	16.7%	10.0%	6.2%	0.145
	(12.1-28.3)	(12.4-51.3)	(11.6-55.1)	(-0.5-33.9)	(-3.1-23.1)	(-5.6-18.1)	

UCS, Universal Coverage Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure

[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

[c]:the percentage of households in which total household expenditure was less than poverty line

[d]:the percentage of households in which total household expenditure after paying OOP for health, was less than poverty line

Supplementary Table S6B Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment in SSS.

Quintiles of socioeconomic status	Total (95% CI)	1 (95% CI)	2 (95% CI)	3 (95% CI)	4 (95% CI)	5 (95% CI)	P-value
CKD15-60 (N=24)							
Pre-out-of-pocket impoverishment [a]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [b]	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	16.7% (-13.2-46.5)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.708
Pre-out-of-pocket impoverishment [c]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [d]	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	16.7% (-13.2-46.5)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.708
CKD<15(N=15)							
Pre-out-of-pocket impoverishment [a]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [b]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Pre-out-of-pocket impoverishment [c]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [d]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
PD (N=11)							
Pre-out-of-pocket impoverishment [a]	0.09%[e]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [b]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Pre-out-of-pocket impoverishment [c]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-

Quintiles of socioeconomic status	**Total**	**1**	**2**	**3**	**4**	**5**	**P-value**
	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	
	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
HD (N=59)							
Pre-out-of-pocket impoverishment [a]	8.5%	31.2%	0.0%	0.0%	0.0%	0.0%	**0.007**
	(1.4-15.6)	(8.5-54.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	24.1%	54.5%	16.7%	27.3%	9.1%	11.1%	0.126
	(12.7-35.5)	(25.1-84.0)	(-4.4-37.8)	(1.0-53.6)	(-7.9-26.1)	(-9.4-31.6)	
Pre-out-of-pocket impoverishment [c]	1.7%	6.2%	0.0%	0.0%	0.0%	0.0%	1.000
	(-1.6-5.0)	(-5.6-18.1)	(0.0-.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	10.2%	25.0%	0.0%	9.1%	9.1%	0.0%	0.217
	(2.5-17.9)	(3.8-46.2)	(0.0-0.0)	(-7.9-26.1)	(-7.9-26.1)	(0.0-0.0)	

SSS, Social Security System, CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2,

PD peritoneal dialysis, HD hemodialysis

[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure

[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

[c]:the percentage of households in which total household expenditure was less than poverty line

[d]:the percentage of households in which total household expenditure after paying OOP for health, was less than poverty line, [e] 1 patient with pre-OOP impoverishment

Supplementary Table S6C Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment in CSMBS.

Quintiles of socioeconomic status	**Total** (95% CI)	**1** (95% CI)	**2** (95% CI)	**3** (95% CI)	**4** (95% CI)	**5** (95% CI)	**P-value**
CKD15-60 (N=258)							
Pre-out-of-pocket impoverishment [a]	3.9%	19.6%	0.0%	0.0%	0.0%	0.0%	**< 0.001**
	(1.5-6.2)	(8.7-30.5)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	4.8%	12.2%	5.1%	3.4%	4.0%	0.0%	0.167
	(2.2-7.5)	(2.2-22.2)	(-0.5-10.7)	(-1.2-8.0)	(-1.4-9.4)	(0.0-0.0)	
Pre-out-of-pocket impoverishment [c]	0.8%	3.9%	0.0%	0.0%	0.0%	0.0%	0.098
	(-0.3-1.8)	(-1.4-9.2)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	2.3%	2.0%	3.4%	3.4%	2.0%	0.0%	0.904
	(0.5-4.2)	(-1.8-5.8)	(-1.2-8.0)	(-1.2-8.0)	(-1.9-5.9)	(0.0-0.0)	
CKD<15 (N=90)							
Pre-out-of-pocket impoverishment [a]	4.4%	16.7%	0.0%	0.0%	0.0%	0.0%	**0.029**
	(0.2-8.7)	(1.8-31.6)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	4.7%	20.0%	0.0%	0.0%	0.0%	0.0%	**0.007**
	(0.2-9.1)	(2.5-37.5)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Pre-out-of-pocket impoverishment [c]	1.1%	4.2%	0.0%	0.0 %	0.0%	0.0%	1.000
	(-1.1-3.3)	(-3.8-12.2)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	0.0 %	0.0%	0.0%	0.0%	0.0%	0.0%	-
	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
PD (N=61)							
Pre-out-of-pocket impoverishment [a]	4.9%	30.0%	0.0%	0.0%	0.0%	0.0%	**0.006**
	(-0.5-10.3)	(1.6-58.4)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	6.9 %	28.6%	9.1	7.7	0.0	0.0	0.090
	(0.4-13.4)	(-4.9-62.0)	(-7.9-26.1)	(-6.8-22.2)	(0.0-0.0)	(0.0-0.0)	
Pre-out-of-pocket impoverishment [c]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-

Quintiles of socioeconomic status	**Total**	**1**	**2**	**3**	**4**	**5**	**P-value**
	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	
	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [d]	3.3%	10.0%	9.1%	0.0%	0.0%	0.0%	0.280
	(-1.2-7.7)	(-8.6-28.6)	(-7.9-26.1)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
HD (N=166)							
Pre-out-of-pocket impoverishment [a]	2.4%	13.3%	0.0%	0.0%	0.0%	0.0%	**0.001**
	(0.1-4.7)	(1.2-25.5)	(0.0-0.0)	(0.0; 0.0)	(0.0; 0.0)	(0.0-0.0)	
Medical impoverishment [b]	13.6%	50.0%	12.9%	8.8%	0.0%	5.1%	**< 0.001**
	(8.3-18.9)	(30.8-69.2)	(1.1-24.7)	(-0.7; 18.4)	(0.0; 0.0)	(-1.8-12.1)	
Pre-out-of-pocket impoverishment [c]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0; 0.0)	(0.0; 0.0)	(0.0-0.0)	
Medical impoverishment [d]	6.0%	16.7%	3.2%	5.9%	0.0%	5.1%	0.095
	(2.4-9.6)	(3.3-30.0)	(-3.0-9.4)	(-2.0; 13.8)	(0.0; 0.0)	(-1.8-12.1)	

CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure

[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

[c]:the percentage of households in which total household expenditure was less than poverty line[d]:the percentage of households in which total household expenditure after paying OOP for health, was less than poverty line

Supplementary Table S7 Factors associated with CHE.
Supplementary Table S7A Factors associated with CHE. (no interaction)

Covariates (reference)	AOR	95% CI	P value
Health insurance schemes (UCS)			
SSS	0.947	0.446 - 2.009	0.886
CSMBS	0.903	0.590 - 1.381	0.636
CKD groups (CKD15-60)			
CKD<15	0.709	0.371 - 1.355	0.298
PD	3.321	2.072 - 5.322	< 0.001
HD	8.828	5.295 - 14.718	< 0.001
Age	1.026	1.009 - 1.043	0.002
Female	1.155	0.801 - 1.667	0.440
Diabetes	0.784	0.533 - 1.154	0.218
Hypertension	0.627	0.393 - 1.001	0.051
Cardiovascular disease	1.871	1.187 - 2.950	0.007
dyslipidemia	1.044	0.791 - 1.377	0.763
Annual patient income	0.999	0.999 - 0.999	0.006
Household size	0.827	0.745 - 0.918	< 0.001

AOR, adjusted odds ratio

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

Supplementary Table S7B Factors associated with CHE. (with interaction)

Covariates (reference)	AOR	95% CI	P value
Interaction between health insurance schemes and CKD (UCS, CKD15-60)			
UCS, CKD<15	1.188	0.691 - 2.042	0.534
UCS, PD	3.534	1.598 - 7.813	0.002
UCS, HD	16.280	8.173 - 32.430	< 0.001
SSS, CKD15-60	1.724	0.278 - 10.693	0.559
SSS, CKD<15	NA		
SSS, PD	21.153	5.856 - 76.406	< 0.001
SSS, HD	8.301	3.073 - 22.428	< 0.001
CSMBS, CKD15-60	1.314	0.778 - 2.220	0.307
CSMBS, CKD<15	0.619	0.232 - 1.651	0.338
CSMBS, PD	4.946	2.387 - 10.247	< 0.001
CSMBS, HD	9.394	5.197 - 16.978	< 0.001
Age	1.027	1.011 - 1.043	0.001
Female	1.215	0.845 - 1.748	0.293
Diabetes	2.791	0.527 - 1.186	0.256
Hypertension	0.598	0.361 - 0.992	0.046
Cardiovascular disease	1.836	1.175 - 2.869	0.008
dyslipidemia	1.041	0.784 - 1.383	0.781
Annual patient income	0.999	0.999 - 0.999	0.004
Household size	0.827	0.744 - 0.919	< 0.001

AOR, adjusted odds ratio, NA cannot be calculated due to small number of patients

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

The hidden financial catastrophe of chronic kidney disease under universal coverage and Thai 'Peritoneal Dialysis First Policy'

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Word count: Abstract=297, text=3,046, tables =3, figures =2

Keywords: Asia, catastrophic health expenditure, economic, kidney failure, impoverishment, universal health insurance

Abstract

Objective: Universal health coverage can decrease the magnitude of the individual patient's financial burden of chronic kidney disease (CKD), but the residual financial hardship from the patients' perspective has not been well studied in low and middle-income countries (LMICs). This study aimed to evaluate the residual financial burden in patients with CKD stage 3 to dialysis in the 'PD First Policy' under Universal Coverage Scheme (UCS) in Thailand.

Methods: This multicenter nationwide cross-sectional study in Thailand enrolled 1,224 patients with pre-dialysis CKD, hemodialysis (HD), and peritoneal dialysis (PD)) covered by UCS and other health schemes for employees and civil servants. We interviewed patients to estimate the proportion with catastrophic health expenditure (CHE) and medical impoverishment. The risk factors associated with CHE were analyzed by multivariable logistic regression.

Results: Under UCS, the total out-of-pocket expenditure in HD was over two times higher than PD and nearly six times higher than CKD stages 3-4. HD suffered significantly more CHE and medical impoverishment than PD and pre-dialysis CKD. (CHE: 8.5%, 9.3%, 19.5%, 50.0% ($p<0.001$) and medical impoverishment: 8.0%, 3.1%, 11.5%, 31.6% ($p<0.001$) for CKD Stages 3-4, Stage 5, PD, and HD, respectively). In the poorest quintile of UCS, medical impoverishment was present in all HD and two-thirds of PD patients. Travel cost was the main driver of CHE in HD. In UCS, the adjusted risk of CHE increased in PD and HD (OR: 3.5 and 16.3, respectively) compared to CKD stage 3.

Conclusions: Despite universal coverage, the residual financial burden remained high in patients with kidney failure. CHE was considerably lower in PD than HD, although the rates remained alarmingly high in the poor. The 'PD First' program' could serve as a model for other LMICs. However, strategies to minimize financial distress should be further developed, especially for the poor.

Introduction

Chronic kidney disease (CKD) is a leading cause of catastrophic health expenditure (CHE) and impoverishment worldwide (1-3). As CKD progresses to kidney failure, kidney replacement therapy is generally provided through public funds in high-income countries. In low-income countries, government funding is not available, and the high out-of-pocket costs make kidney replacement unaffordable for most people. Kidney replacement in middle-income countries may be provided by combined public and private sources (4, 5). Globally, hemodialysis (HD) is the most widely used kidney replacement modality, although it incurs higher costs as it is usually performed in centers in large cities (3, 4). Continuous ambulatory peritoneal dialysis (PD) requires less infrastructure development as patients are treated at home but are used less frequently. By contrast, transplantation is less commonly performed in low and middle-income countries (LMICs).

Universal health coverage can decrease the magnitude of the individual patient's financial burden of CKD,(4, 5) but in LMICs, coverage for kidney replacement is often not included because of the high costs. Thailand is an upper-middle-income country with a population of 70 million. The prevalence of CKD stages 1-5 in Thailand was 8.7 %, (6) and the number of patients on kidney replacement therapy in 2020 included 129,724 HD patients and 34,467 PD patients. (7) In 2002, the Thai government initiated the Universal Coverage Scheme (UCS) to cover previously uninsured subjects outside the other two public schemes: the Social Security Scheme (SSS) for company employees and the Civil Servant Medical Benefit Scheme (CSMBS) (8). In 2008, the UCS coverage was extended to dialysis care in a 'PD First Policy', meaning that all new kidney failure patients must use PD as first-line therapy (9-11). Only patients with contraindications to PD were eligible for reimbursement for the cost of HD. By comparison, both HD and PD are reimbursable under SSS or CSMBS. All healthcare schemes provide coverage for essential medications. With UCS accounting for 75% of the population, kidney replacement coverage in Thailand for all healthcare schemes is 98.5%.(8, 12) As such, UCS and the 'PD First' program in Thailand has often been used as a successful example of kidney care policy in a resource-limited setting (4, 5, 13).

The core principle of universal coverage means that all people have adequate health services without financial hardship (4, 5). Surveys based on expert opinions have provided valuable data on the costs of kidney replacement to governments around the world (14). Still, the residual financial hardship from the patients' perspective despite universal coverage in LMICs including Thailand remains unknown. The out-of-pocket spending for costs not included in the benefits package may be catastrophic for patients and their families. This study aimed to evaluate the out-of-pocket expenditure, CHE, and impoverishment in CKD stage 3 to dialysis under UCS and the 'PD First' strategy in a multicenter nationwide study in Thailand by direct patient interviews. For comparisons, we also studied patients under SSS and CSMBS. This information will provide essential data for policy decision-makers in LMICs contemplating universal coverage for kidney replacement.

Methods

Study design

This cross-sectional multicenter nationwide study is reported by following the STROBE Statement (15).

Data Source and Target Population

We conducted this study in 11 tertiary or regional hospitals covering all five regions in Thailand between June 2019 and January 2021 as part of the CORE-CKD study (TCTR20211209001) (www.thaiclinicaltrials.org). Patients (n=100-200) were randomly selected from each hospital. The study population consisted of four groups of CKD patients aged 18 years or older: CKD 15-60 ml/min/1.73m^2 (Stages 3-4), CKD <15 ml/min/1.73m^2 (stage 5, but not on dialysis), PD and HD covered by health insurance schemes; Universal Coverage Scheme (UCS), Social Security System (SSS), Civil Servant Monetary Benefit Scheme (CSMBS) (**Supplementary Table S1)** (12). We excluded patients with incomplete expenditure data or those who entirely self-paid.

Data Collection

We collected demographic and clinical data by interviewing patients and caregivers and reviewing medical charts (**Supplementary Questionnaire**). The estimated GFR (eGFR) was calculated by the CKD-EPI equation (16). *Socioeconomic data* included patient income, food expenditure, and total household consumption spending within one month preceding the interview. O*ut-of-pocket expenditures (OOPE)* within six months before the interview were collected and categorized into medical or non-medical. Medical OOPE consisted of co-payments, which the health schemes did not cover. Non-medical OOPE consisted of food, transportation, accommodation during clinic visits and hospital admissions, home renovations or expenses for patients' care. Total annual expenditures were calculated in Thai baht, adjusted with the cumulative inflation rate from the data collection to 2021, and then converted to US dollars using the exchange rate in January 2021.

Outcomes of interest

Financial hardship was measured by the proportion of patients with Catastrophic Health Expenditure (CHE) as the primary outcome and the proportion of medical impoverishment as the secondary outcome. ***CHE40*** was defined as a condition that patient's health care expenditure was at least 40% of the household's capacity to pay as used by WHO (17). Capacity to pay was defined as the effective income (based on total household expenditure) remaining after subtracting basic subsistence costs. We defined pre-out-of-pocket impoverishment based on total household expenditure below the computed subsistence expenditure before deduction of OOPE for health. ***Medical impoverishment*** was

defined as non-poor households that became poor after OOPE for healthcare services (18, 19).

Statistical analysis

Categorical data were shown as numbers and percentages and compared using the Chi-squared test or Fisher's exact test. Continuous variables were shown as mean with standard deviations (SD) or median with interquartile range (IQR) and compared using one-way analysis of variance, or Kruskal-Wallis test, as appropriate. The proportion (%) of CHE and medical impoverishment were compared among CKD and health schemes. CHE and medical impoverishment were compared across socioeconomic groups, ranked into quintiles based on the equivalized per capita total household expenditure.

We performed multivariable logistic regression analysis to determine factors affecting CHE controlling for the following covariates: age, gender, types of health schemes, groups of CKD, comorbidities (diabetes, hypertension, dyslipidemia, and cardiovascular disease), annual patient income and the number of household members. We also included the interaction terms between groups of CKD and health schemes in the models. The adjusted probability of CHE among different CKD groups, health insurance schemes and geographic regions was calculated. We also performed variance correction for correlation due to the cluster site.

We performed sensitivity analyses by 1) defining ***CHE10*** as an OOPE for health over 10% threshold level of total household consumption expenditure (18, 19).
or 2) defining impoverishment based on Thailand's National poverty line year 2019 (20). All analyses were performed using STATA 16.1, and statistical significance was set at $p < 0.05$.

Results

Patient characteristics

Of initial participants (n=1,239), we excluded two patients with incomplete expenditure data and thirteen patients who were entirely self-paid (**Supplementary Figure S1**). A total of 1,224 patients (CKD15-60 (n = 435); CKD<15 (n = 213); PD (n = 257); HD (n = 319)) participated in the study (**Table 1**). There were 44% under UCS, 9% under SSS and 47% under CSMBS health schemes.

Household expenditure and Out-of-pocket expenditure

The total household expenditures (effective income) were similar in CKD15-60 compared to HD or PD in all schemes (**Supplementary Table S2**). Patient income and/or the total household expenditures were lower in UCS than CSMBS in all CKD groups (**Supplementary Table S3**).

The total OOPE in pre-dialysis CKD was comparable across all health schemes (**Supplementary Table S3**). Dialysis patients had higher total OOPE than pre-dialysis patients in all schemes, with HD having larger OOPE than PD in UCS and CSMBS. Under UCS, the

total OOPE in HD was over two times higher than PD and nearly six times higher than CKD15-60. (Total OOPE (USD/year) for UCS: CKD15-60, 302 (205-400); CKD<15, 626 (311-941); PD,759 (580-938); HD,1775 (1262-2288)**,** p<0.001). A similar trend was observed under CSMBS, but the OOPE was higher in CSMBS compared to UCS (**Supplementary Table S2, Supplementary Table S3**). Both medical and non-medical costs contributed to the marked increase in total OOPE in HD and PD patients. Travel cost was a major driver of OOPE in HD patients in all three schemes accounting for 44-49.3% of total OOPE (**Figure 1, Supplementary Table S4**). In contrast to other schemes, the OOPE under SSS was highest in PD, partly due to higher medical costs.

Catastrophic health expenditure

CHE40 ranged from 0% to 11% in pre-dialysis CKD (**Table 2, Supplementary Figure S2A**). CHE40 was higher in dialysis patients compared to pre-dialysis CKD in all schemes. For UCS, CHE40 were: 8.5%, 9.3%, 19.5%, and 50.0%, for CKD15-60, CKD<15, PD, and HD, respectively (p<0.001). A similar pattern was seen in CSMBS, although the differences between PD (25%) and HD (39%) were less marked. By comparison, in SSS patients, CHE40 was higher in PD than HD.

CHE40 was higher in the lowest socioeconomic quintile, with more dialysis patients affected than pre-dialysis CKD. In the poorest quintile of UCS, the CHE40 were: 19%, 32%, 31%, and 82% for CKD15-60, CKD<15, PD, and HD, respectively (p<0.001). For the poorest quintile of CSMBS, about 70% of PD and HD patients had CHE40 compared to about 17% of pre-dialysis CKD (**Figure 2A-C, Supplementary Table S5A-C**).

In the sensitivity analysis (**Supplementary Table S3A-D, Supplementary Table S6**), the results showed the same trend, but the proportions of CHE10 were higher. CHE10 under UCS were CKD15-60 15.7%, CKD<15 19.4%, PD, 40.5%, and HD 67.0% (p<0.001).

Medical impoverishment

The pre-out-of-pocket impoverishment (the total household expenditure below the computed subsistence expenditure) was higher in UCS (16%) compared to SSS (6%) and CSMBS (4%) (p < 0.001) (**Table 2, Supplementary Figure S2B**). Pre-out-of-pocket impoverishment was similar across CKD groups in UCS and CSMBS. Medical impoverishment was most common in all schemes in HD patients, being highest in UCS. The proportion with medical impoverishment under UCS were: 8.0%, 3.1%, 11.5%, 31.6% for CKD15-60, CKD<15, PD, and HD, respectively (p<0.001). Medical impoverishment in pre-dialysis CKD and PD were not different between UCS and CSMBS.

The proportion of medical impoverishment in the poorest quintile of patients was highest in HD in all schemes affecting 100%, 55%, and 50% of UCS, SSS, CSMBS, respectively (**Supplementary Table S7A-C, Supplementary Figure S3A-C**). In the poorest quintile of UCS, medical impoverishment was also considerable in PD (67%) and pre-dialysis CKD (50%) patients. These values compare to 28% of PD and 12- 20% of pre-dialysis CKD patients in the lowest quintile of CSMBS (**Supplementary Table S7A-C, Supplementary Figure S3A-C**).

In the sensitivity analysis, HD patients still had the highest rate of impoverishment in all insurance schemes using the poverty line to define impoverishment (**Supplementary Table S3A-D, Supplementary Table S6**). For UCS, the medical impoverishment based on poverty line were CKD15-60 4.6%, CKD<15 3.7%, PD 3.8%, HD 20%.

Factors associated with CHE

Compared with CKD15-60, PD and HD increased the adjusted risk of CHE40 by 3.3 and 8.8 folds, respectively (**Table 3**). After inclusion of the interaction between health schemes and CKD groups into the model, CHE40 risk in UCS in PD and HD increased by 3.5 and 16.3 folds, respectively. A similar pattern was seen for CSMBS, whereas in SSS, PD had a greater risk of CHE compared to HD. Other significant risk factors were older age, cardiovascular disease, absence of hypertension, and low numbers of household members.

The probability of CHE

The adjusted probability of CHE40 ranged from 5% to 12% for pre-dialysis CKD (**Supplementary Table S8**). Under UCS, the adjusted probability of CHE40 was higher ($p < 0.05$) in HD (52.7%) compared to PD (21.5%), CKD<15 (8.8 %), and CKD15-60 (7.6 %) (**Supplementary Figure S4**). CSMBS showed a similar trend, but the differences between HD (40.3%) and PD (27.2%) did not reach statistical significance (**Supplementary Table S8, Supplementary Figure S4**). The results for CHE10 were in a similar direction as the main findings (**Table 3, Supplementary Table S8**).

The probability of CHE by geographic regions

We also analyzed the effect of different regions on the probability of CHE. We found that the adjusted prevalence of CHE40 was higher in the Central compared to the North, East and South regions, and the adjusted prevalence of CHE40 was higher in the Northeast compared to the North, and East regions. The adjusted prevalence of CHE10 also showed a higher prevalence of the Central region. (**Supplementary Table S9**)

Discussion

Despite universal coverage, there was substantial residual financial hardship in CKD patients, increasing from pre-dialysis to PD to HD. Under UCS and the 'PD First Policy', HD patients had the largest financial burden, whereas PD patients had a lower burden. Half of the HD patients had CHE, and 20% had medical impoverishment compared to 20% and 11% of PD patients. In the poorest UCS patients, medical impoverishment was almost 100% in HD and over 60% in PD. Non-medical costs especially traveling costs, were the main out-of-pocket expenditure in HD.

UCS reduced the burden of health care, especially among the poor (21, 22). In the Thai population, medical impoverishment (using the national poverty line) decreased from 2.3% in 1990 to 0.3% in 2015. Over the same period, CHE decreased from 7.1% to 2.1% (12), which is several folds lower than the global proportion of 12% (23). Previously, there have been no studies on the residual financial burden in CKD under universal coverage. Our

data showed that CHE or medical impoverishment (defined by the poverty line) in pre-dialysis CKD was about ten folds above the population average (21, 22). CKD patients have multiple co-morbidities. Travel costs to tertiary centers contribute to the out-of-pocket expenditure, whereas medical costs account for less than one-third of all out-of-pocket expenditure as health schemes cover most medication costs. Pre-dialysis CKD patients were better off than dialysis patients because their health status was generally better with less frequent hospital visits.

Since the initiation of dialysis coverage under the 'PD First Policy', the number of cases of kidney replacement in Thailand increased from 21,839 in 2007 to 164,191 in 2020, while PD increased from 5.5% to 21% of dialysis patients (7, 24). This massive increase was only achievable with the UCS program, as self-payment is too expensive for most patients.(25) Nonetheless, our study shows that despite universal coverage, kidney failure still results in a substantial financial burden, especially in patients on HD.

Although data on the cost to the government for providing dialysis services in LMICs are available,(3, 4) so far, very few studies have investigated the cost implications of CKD from the patients' perspective relative to their income. Without universal coverage, the burden of HD on patients in an LMIC is enormous. A recent study in HD patients from Kerala state, India, found that over 90% of households, who mainly did not have financial assistance, had CHE (26). Hemodialysis and medical costs were the main drivers of out-of-pocket expenditure in these privately funded patients (26). The lower CHE in our HD patients partly reflects the benefits of government coverage. The cost of HD for SSS or CSMBS patients or UCS patients with contraindications to PD is fully covered in government centers, but there may be extra co-payments in private centers. Co-payment for pre-approved HD, medications not listed in essential drug lists, and other health services, including vascular access formation at a non-registered hospital, accounted for higher medical out-of-pocket expenditure among HD patients under UCS than those under CSMBS (12, 27). With the dialysis cost being mostly covered, frequent traveling was a major out-of-pocket expenditure in HD under all health schemes consistent with other studies (26, 28).

The lower earnings of UCS patients increases the risk for CHE in the face of higher out-of-pocket expenditure incurred during HD, with the poorest suffering more from this excess burden. The higher cost of HD and the requirement of specialized centers and staff means that LMICS that has offered HD as an initial modality under universal coverage may have difficulty in achieving adequate dialysis coverage due to a lack of hemodialysis centers in remote areas (29). In addition, patients may skip dialysis sessions as they cannot pay the extra out-of-pocket costs in countries where hemodialysis coverage is only partial (30).

Few other studies have compared the financial burden across the spectrum from pre-dialysis CKD to PD and HD in the LMIC. Bello et al. showed that the percentage of monthly spending on health was 5-fold higher in HD than PD patients in a small study in South-African children (31). In our study, the odds of developing CHE under UCS were 2-fold higher for HD than for PD. The probability of CHE of PD under UCS is comparable to HD or PD under CSMBS despite lower income in the UCS group. The lower financial burden of PD compared to HD under UCS is consistent with the benefit of the 'PD First Policy', especially for the poor. PD is a home-based treatment with comparable outcomes to HD and requires less travel time (10). The lower need for health personnel and infrastructure allows greater access in remote areas and is more cost-effective than HD. In addition to lower traveling needs, the lower out-of-pocket expenditure for PD is dependent on the provision of free

dialysate in the UCS scheme (9). The higher out-of-pocket expenditure and CHE rate for SSS may reflect incomplete reimbursement for PD in this scheme. In countries where peritoneal fluid cannot be imported cheaply, the cost-benefit of a 'PD First' program may be altered (5). The higher prevalence of CHE in the Central region may reflect higher cost of living.

Our study has several strengths. This study is the first multicenter nationwide study to describe the residual financial burden of CKD patients under universal coverage and the 'PD First Policy' to allow true insight into the economic impact on CKD households in Thailand. To our knowledge, we are among the first to evaluate the patient financial burden in a spectrum of CKD and dialysis patients using data obtained directly from patients in an LMIC.

There were several limitations in our study. Firstly, the cross-sectional design may not capture the fluctuation of expenditures throughout the year. Secondly, interview data may be subjected to recall bias. This study excluded the tiny proportion of UCS patients who used HD without approved indications and must cover the total treatment price for dialysis. Finally, our study contained relatively few SSS patients which may lead to bias in our data from this group.

This study provides data for policymakers in LMICs that should be useful in selecting the preferred dialysis modality for universal coverage (10, 30). Our study should warn policymakers of HD's considerable financial hardship. Without full knowledge of the hidden out-of-pocket expenditure, choosing HD could be catastrophic for many households in the long term. Financial distress in many dialysis patients should lead to strategies to support at-risk patients including more hemodialysis facilities in remote areas or transportation services for patients for whom HD is the only viable option (32). However, whether these options are feasible needs to be evaluated in the local context. Finally, it is important to consider that the dimension of the natural history of CKD is a continuous process (transitioning at different rates from one stage to the next) and so as the burden of disease, economic consequences and risk of CHE and medical impoverishment are also dependent on time that people have lived in the previous stage (and what they had already spent).

Conclusion

Kidney failure patients had increased catastrophic health expenditure and medical impoverishment than pre-dialysis CKD. Under the 'PD First' program for UCS, the financial hardship for patients on PD was considerably lower than HD, although the rates remained alarmingly high in the poor.

Data Availability Statement

Data sharing is applicable. Request to access the datasets, please directly contact the corresponding author. Please note that all personal information such as name, address, ID number and contact had been removed from the datasets.

Ethics statement

The study was reviewed and approved by Research Ethics Board at Central Research Ethics Committee. (ID: COA-CREC 005/57). All participants provided written consent before enrollment.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

PoS, PiT, PaS, NC, CKi were responsible for concept and design of the study
PiS and CKi were responsible for funding.
PoS, PK, SA, SB, PG, CKu, PL, KN, WP, SS, PlT, PuT were responsible for patient evaluation and data collection
PoS, SLG, PiT, PaS, NC, CKi were responsible for data analysis.
PoS, NC, CKi were responsible for first draft of the manuscript.
All authors were responsible for writing the final version of the manuscript and approving the final version.

Funding

PiS was funded by HSRI grant ID 57-108. CKi was funded by HSRI grant ID 60-078.
The study funders had no role in study design; data collection, analysis, interpretation or writing the report. The corresponding authors had full access to all study data and had final responsibility for the decision to submit for publication.

Acknowledgements

The authors would like acknowledge the following for assistance with patient enrollment:
Songklanagarind Hospital, Paveena Nanphan, Bhumibol Adulyadej Hospital, Rattinan Singprasert, Chiang Mai University, Orapan Pankum; Nakornping Hospital, Kittiya Sattaya: Naresuan University, Parttarawee Damee; Maharat Nakhon Ratchasima Hospital, Sumalee

Klungklang; Somdej Phranangchao Siririkit,Thidaratn Phetchai; Srinagarind Hospital, Buppa Tongdeenok; Sunprasitthiprasong Hospital, Nongnuch Kuankote; Vachiraphuket Hospital, Renu Wonggerdprayot.

Supplementary Material

Supplementary Questionnaire. Questionnaire for health economic data collection
Supplementary Table S1. Characteristics of Thailand's main health insurance schemes[a]
Supplementary Table S2. Socioeconomic characteristics and out-of-pocket expenditures by CKD groups
Supplementary Table S3. Socioeconomic, out-of-pocket (OOP) expenditures, Catastrophic Health Expenditure (CHE) and impoverishment by health insurance schemes in CKD groups (**Supplementary Table S3A-D**)
Supplementary Table S4. Out-of-pocket expenditure as the percentage of total out-of-pocket expenditures for health
Supplementary Table S5. Socioeconomic status quintiles-specific proportion of Catastrophic Health Expenditure (CHE) (**Supplementary Table S5A-C**)
Supplementary Table S6. Proportion of Catastrophic Health Expenditure (CHE10) and impoverishment using poverty line by CKD groups
Supplementary Table S7. Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment (**Supplementary Table S7A-C**)
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Supplementary Figure S4. Probability of Catastrophic Health Expenditure (CHE40)[a] by Health insurance schemes and CKD groups

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Table 1. Demographic and clinical characteristics by CKD groups

Characteristics	Total(%)	CKD15-60(%)	CKD<15(%)	PD(%)	HD(%)
Number of patients	1224	435	213	257	319
Demographic data					
Age (years) [a]	63.8 (14.3)	69.0 (12.2)	65.7 (13.2)	58.2 (14.8)	59.8 (14.3)
Female	538 (44)	170 (39.1)	117 (54.9)	115 (44.7)	136 (42.6)
Health insurance schemes					
UCS	540 (44.1)	153 (35.2)	108 (50.7)	185 (72.0)	94 (29.5)
SSS	109 (8.9)	24 (5.5)	15 (7.0)	11 (4.3)	59 (18.5)
CSMBS	575 (47.0)	258 (59.3)	90 (42.3)	61 (23.7)	166 (52.0)
Clinical characteristics					
eGFR(ml/min/1.73m^2) [b]	8(5-25)	32 (23-42)	9(7-13)	4 (4-6)	5 (4-6)
Duration of CKD (months) [b]		48 (22-108)	36 (20-68.5)	N/A	N/A
Duration of dialysis (months) [b]		N/A	N/A	35 (20-61.0)	58 (32-100)
Diabetes	552 (45.1)	203 (46.7)	111 (52.1)	109 (42.4)	129 (40.4)
Hypertension	1121 (91.6)	377 (86.7)	196 (92.0)	242 (94.2)	306 (95.9)
Cardiovascular disease	188 (15.4)	60 (13.8)	28 (13.1)	44 (17.1)	56 (17.6)
Dyslipidemia	871 (71.2)	339 (77.9)	159 (74.6)	162 (63.0)	211 (66.1)
Sites of study					
Provincial hospital	514 (42.0)	164 (37.7)	90 (42.3)	116 (45.1)	144 (45.1)
University hospital	710 (58.0)	271 (62.3)	123 (57.7)	141 (54.9)	175 (54.9)

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a] mean (SD), [b] median (IQR), N/A=not applicable

Table 2. Proportion of Catastrophic Health Expenditure (CHE40) and impoverishment by CKD groups

	Total (95%CI)	**CKD15-60** (95%CI)	**CKD<15** (95%CI)	**PD** (95%CI)	**HD** (95%CI)	**P-value**
CHE40 [a]						
UCS	19.6% (16.3-23.0)	8.5% (4.1-12.9)	9.3% (3.8-14.7)	19.5%*$ (13.8-25.2)	50.0%*$ # (39.9-60.1)	**< 0.001**
SSS	24.8% (16.7-32.9)	8.3% (-2.7-19.4)	0.0% (0.0-0.0)	54.5%*$ (25.1-84.0)	32.2%*$ (20.3-44.1)	**0.001**
CSMBS	19.5% (16.2-22.7)	10.9% (7.1-14.6)	5.6% (0.8-10.3)	24.6%*$ (13.8-35.4)	38.6%*$ # (31.2-46.0)	**< 0.001**
Medical impoverishment						
UCS						
Pre-out-of-pocket impoverishment [b]	16.1% (13.0-19.2)	18.3% (12.2-24.4)	11.1% (5.2-17.0)	15.7 % (10.4-20.9)	19.1% (11.2-27.1)	0.348
Medical impoverishment [c]	12.1% (9.1-15.1)	8.0% (3.2-12.8)	3.1% (-0.4-6.6)	11.5%$ (6.5-16.6)	31.6%*$ # (21.1-42.0)	< 0.001
SSS						
Pre-out-of-pocket impoverishment [b]	5.5% (1.2-9.8)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	9.1% (-7.9-26.1)	8.5% (1.4-15.6)	0.374
Medical impoverishment [c]	13.6% (7.0-20.2)	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	24.1% (12.7-35.5)	**0.016**
CSMBS						
Pre-out-of-pocket impoverishment [b]	3.7% (2.1-5.2)	3.9% (1.5-6.2)	4.4% (0.2-8.7)	4.9 % (-0.5-10.3)	2.4% (0.1-4.7)	0.668
Medical impoverishment [c]	7.6% (5.4-9.8)	4.8% (2.2-7.5)	4.7% (0.2-9.1)	6.9% (0.4-13.4)	13.6%*$ # (8.3-18.9)	**0.011**

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme, 95% CI, 95% Confidence Interval

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

*P-value <0.05 vs CKD15-60, $ P-value <0.05 vs CKD<15, # P-value <0.05 vs PD

[a] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[b] The percentage of households in which total household expenditure was less than computed subsistence expenditure
[c] The percentage of households in which total household expenditure after paying out-of-pocket for health was less than computed subsistence expenditure

Table 3. Multivariable Analysis of health insurance schemes and CKD groups on CHE

Covariates (reference)	CHE40 [a]			CHE10 [b]		
	AOR [c]	95% CI	P value	AOR [c]	95% CI	P value
Health insurance schemes (UCS)						
SSS	0.947	0.446-2.009	0.886	1.262	0.808-1.971	0.306
CSMBS	0.903	0.590-1.381	0.636	1.180	0.963-1.446	0.111
CKD groups (CKD15-60)						
CKD<15	0.709	0.371-1.355	0.298	1.525	1.017-2.285	**0.041**
PD	3.321	2.072-5.322	< **0.001**	4.459	2.332-8.528	< **0.001**
HD	8.828	5.295-14.718	< **0.001**	11.084	8.073-15.218	< **0.001**
Interaction between health insurance schemes and CKD (UCS, CKD15-60)						
UCS, CKD<15	1.188	0.691-2.042	0.534	1.324	0.860-2.039	0.202
UCS, PD	3.533	1.598-7.813	**0.002**	4.584	1.961-10.714	< **0.001**
UCS, HD	16.280	8.173-32.430	< **0.001**	14.390	8.671-23.883	< **0.001**
SSS, CKD15-60	1.724	0.278-10.693	0.559	0.712	0.144-3.515	0.677
SSS, CKD<15	NA			2.595	1.267-5.316	**0.009**
SSS, PD	21.153	5.856-76.406	< **0.001**	19.513	5.805-65.589	< **0.001**
SSS, HD	8.301	3.073-22.428	< **0.001**	12.286	6.507-23.198	< **0.001**
CSMBS, CKD15-60	1.314	0.778-2.220	0.307	1.284	0.909-1.815	0.156
CSMBS, CKD<15	0.619	0.232-1.651	0.338	2.114	1.091-4.097	**0.027**
CSMBS, PD	4.946	2.387-10.247	< **0.001**	4.577	1.884-11.120	**0.001**
CSMBS, HD	9.394	5.198-16.978	< **0.001**	12.679	7.663-20.978	< **0.001**

AOR, adjusted odds ratio, 95% CI, 95% Confidence Interval, NA, cannot be calculated due to small number of patients

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay
[b] The percentage of households in which out-of-pocket payments for health care was more than 10% of households' total consumption expenditure
[c] Adjusted with age, sex, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members

Legend for figures

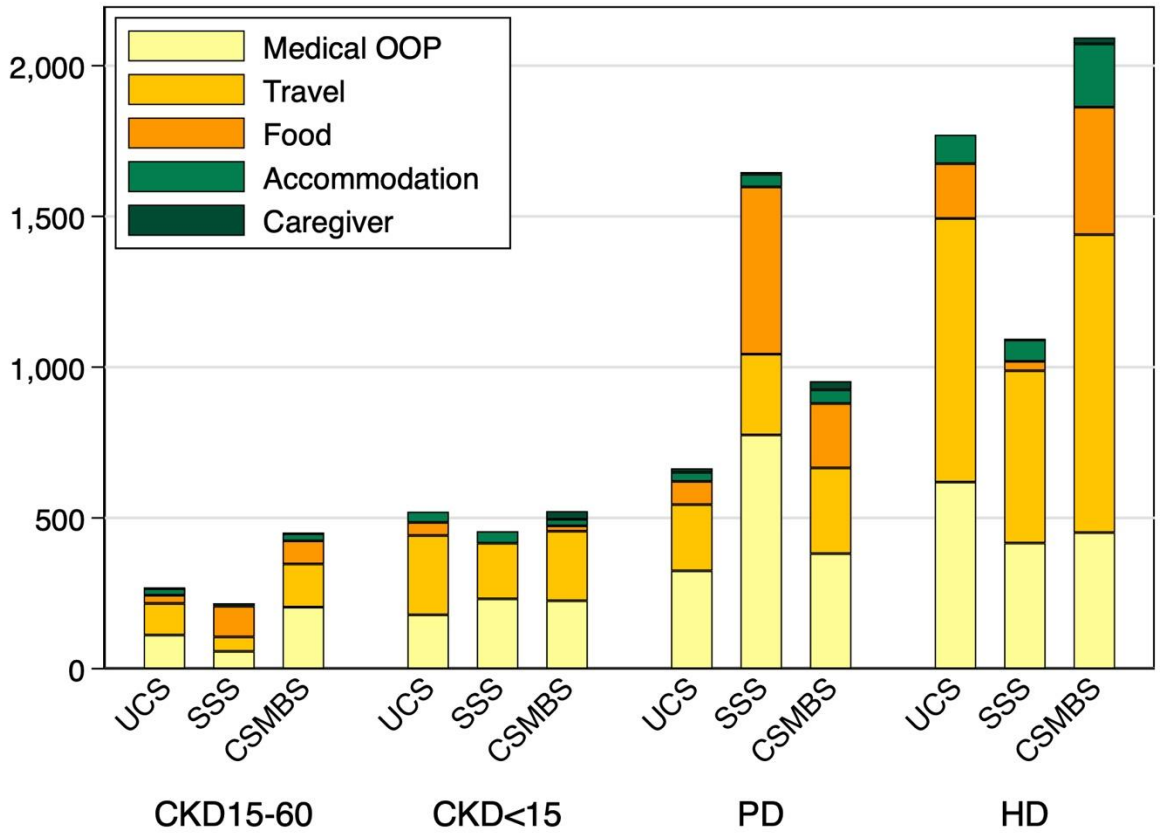


Figure 1. Breakdown of mean annual out-of-pocket cost by health insurance schemes and CKD groups.
UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme. CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

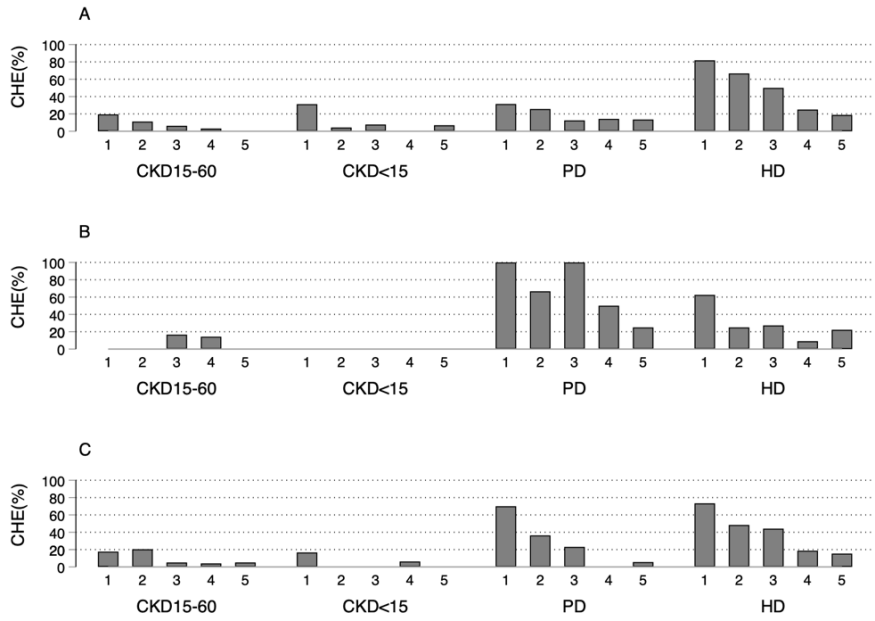


Figure 2. Socioeconomic status quintiles-specific proportion of Catastrophic Health Expenditure (CHE40) under different schemes. (**A) UCS, (B) SSS**, (**C) CSMBS**
CHE40 defined as households in which out-of-pocket payments for health care was at least 40% of household capacity to pay. UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme. CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

The hidden financial catastrophe of chronic kidney disease under universal coverage and Thai 'Peritoneal Dialysis First Policy'

Pornpen Sangthawan[1], Pinkaew Klyprayong [2], Sarayut L. Geater[1], Pimwara Tanvejsilp[3] , Sirirat Anutrakulchai[4], Sarinya Boongird[2], Pongsathorn Gojaseni[5], Charan Kuhiran[6], Pichet Lorvinitnun[7], Kajohnsak Noppakun[8] , Watanyu Parapiboon[9], Supinda Sirilak[10], Pluemjit Tankee[11], Puntapong Taruangsri[12], Pasuree Sangsupawanich[13] , Piyamitr Sritara[2], Nathorn Chaiyakunapruk[14]*, Chagriya Kitiyakara* [2]

Supplementary materials

Supplementary Questionnaire. Questionnaire for health economic data collection

Supplementary Table S1. Characteristics of Thailand's main health insurance schemes[a]

Supplementary Table S2. Socioeconomic characteristics and out-of-pocket expenditures by CKD groups

Supplementary Table S3. Socioeconomic, out-of-pocket (OOP) expenditures, Catastrophic Health Expenditure (CHE) and impoverishment by health insurance schemes in CKD groups (**Supplementary Table S3A-D**)

Supplementary Table S4. Out-of-pocket expenditure as the percentage of total out-of-pocket expenditures for health

Supplementary Table S5. Socioeconomic status quintiles-specific proportion of Catastrophic Health Expenditure (CHE) (**Supplementary Table S5A-C**)

Supplementary Table S6. Proportion of Catastrophic Health Expenditure (CHE10) and impoverishment using poverty line by CKD groups

Supplementary Table S7. Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment (**Supplementary Table S7A-C**)

Supplementary Table S8. Multivariable adjusted probability of Catastrophic Health Expenditure (CHE)

Supplementary Table S9 Probability of incurring Catastrophic Health Expenditure (CHE) by regions from the modeling

Supplementary Figure S1. Flow of study

Supplementary Figure S2. Proportion of Catastrophic Health Expenditure (CHE40) [a] and impoverishment [b,c] according to CKD groups and health insurance schemes

Supplementary Figure S3. Socioeconomic status quintiles-specific proportion of pre-out-of-pocket (pre-OOP)[a] and medical impoverishment[b]

Supplementary Figure S4. Probability of Catastrophic Health Expenditure (CHE40)[a] by Health insurance schemes and CKD groups

Supplementary Questionnaire Questionnaire for health economic data collection

Health Economic	Visit date ☐☐-☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐

Part health economic evaluation

1.monthly patient income

❑ 1. income ☐☐☐☐☐☐ baht/month ❑ 2. no income

2. number of family members and income

2.1. total family member (including patient) ☐☐

2.2. familial income ☐☐☐☐☐☐ baht/month

3. household expenditure

3.1. expense for food

3.1.1. food expense (whole family) ☐☐☐☐ baht/day

3.1.2. average food expense (whole family) ☐☐☐☐☐ baht/month

☐☐ % of total monthly household spending

3.2. total household spending (included cost for daily travel, electricity and water, clothes, tax, donation, not included cigarette, food)

average household spending ☐☐☐☐☐ baht/month

4.Data regarding out-of-pocket spending at OPD visit at study hospital during the past 6 months (including visit for dialysis, procedure)

1. How many visits at OPD during the past 6 months (including this visit)?	☐☐ times
2.How much money did patients pay out-of-pocket for health (cannot reimburse) at OPD visit this hospital during the past 6 months?	☐☐☐☐ baht
3. How many relatives or unpaid caregivers accompany patients for OPD visit?	☐☐ (patient come alone =0)
4. How many hours do patients spend for OPD visit ? (including time for travelling and waiting)	☐☐☐ hours/visit
5. How much extra-money (from routine daily spending for food) has been paid for food for both patients and caregivers on OPD visit day?	☐☐☐☐ baht/visit

Health Economic	Visit date ☐☐/☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐
6. How much of the average cost for the travelling on each OPD visit? (including fuel, public transport, for both patient and caregiver)	☐☐☐☐ baht/visit
7. How much money was paid for accommodation on OPD visit?	☐☐☐☐ baht/visit (no cost =0)
5. Data regarding out-of-pocket spending at OPD visit at other hospitals during the past 6 months (including visit for dialysis, procedure)	
1. How many visits at OPD during the past 6 months (including this visit)?	☐☐ times
2.How much money did patients pay out-of-pocket for health (cannot reimburse) at OPD visit other hospitals during the past 6 months?	☐☐☐☐☐ baht
3. How many relatives or unpaid caregivers accompany patients for OPD visit?	☐☐ (patient come alone =0)
4. How many hours do patients spend for OPD visit ? (including time for travelling and waiting)	☐☐☐ hours/visit
5. How much extra-money (from routine daily spending for food) has been paid for food for both patients and caregivers on OPD visit day?	☐☐☐ baht/visit
6. How much of the average cost for the travelling on each OPD visit? (including fuel, public transport, for both patient and caregiver)	☐☐☐☐☐ baht/visit
7. How much money was paid for accommodation on OPD visit?	☐☐☐☐ baht/visit (no cost =0)
6. Data regarding out-of-pocket spending at IPD admissions at both study and other hospitals during the past 6 months	
1. How many hospital admissions are there during the past 6 months?	❑ 1. yes ☐☐☐ times ❑ 2. no
2. How many admission days have patient spent in	☐☐☐ days

Health Economic	Visit date ☐☐/☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐
hospital during the past 6 months?	
3.How much money did patients pay out-of-pocket for health (cannot reimburse) at IPD admissions during the past 6 months?	☐☐☐☐ baht
4.How many relatives or unpaid caregivers take care of patients for IPD admission during the past 6 months?	☐☐☐ days ☐☐☐ hours/day
5. How much extra-money (from routine daily spending for food) has been paid for food for both patients and caregivers during IPD admission?	☐☐☐☐ baht/day
6. How much of the average cost for the travelling on each IPD admission? (including fuel, public transport, for both patient and caregiver)	☐☐☐☐☐ baht/visit
7.data regarding house improvement and buying equipment for health	
1. Is there any house improvement or buying equipment for health for CKD during the past 6 months?	❑ 1. yes ☐☐ times ❑ 2. no
2.How much money has been paid for equipment for health (such as special bed, wheelchair, etc) during the past 6 months?	☐☐☐☐☐ baht
3.How much money has been paid for house improvement for health during the past 6 months?	☐☐☐☐☐ baht
4.How much money has been paid for other things or facility to improve CKD status during the past 6 months?	☐☐☐☐☐ baht
8.data regarding caregiver during the past 6 months	
1. Does patient need paid caregiver at home?	❑ 1. yes ❑ 2. no
2. if need paid caregiver, how many does patient hire and how much money paid per month?	Number of paid caregiver ☐☐ cost of paid caregiver ☐☐☐☐☐☐ baht/month

Health Economic	Visit date ☐☐/☐☐/25☐☐
Site ID ☐☐	Subject ID ☐☐-☐-☐☐

9.data regarding out of hospital spending for medical cost during the past 6 months

1. Did patient seek medical treatment outside hospitals?	❑ 1.no ❑ 2. yes
2. How much money has patient paid for medicine from drugstore?	☐☐☐☐☐ baht
3. How much money has patient paid for herb?	☐☐☐☐☐ baht
4. How much money has patient paid for supplement?	☐☐☐☐☐ baht
5. How much money has patient paid for other treatment outside hospital?	☐☐☐☐☐ baht

Interviewer ..... ☐-☐ date/month/year ☐☐/☐☐/25☐☐

Table S1 Characteristics of Thailand's main health insurance schemes[a]

Health insurance scheme	**UCS**	**SSS**	**CSMBS**
Population coverage	the rest of Thai people	private sector employees, excluding dependants	government employees and dependants
Percentage coverage	75	16	9
Source of revenue	General tax	Tripartite contribution, equally shared by employer, employee and government	General tax, Non-contributary scheme
Mode of provider payment	Capitation for outpatient and global budget plus Diagnostic Related Group (DRG) for inpatient	Inclusive capitation for both outpatient and inpatient plus additional adjusted payments for accident and emergency and high-cost care	Fee for service, direct disbursement to mostly public providers and DRG for inpatient treatment
Access to service	Registered contractors, the network of public hospitals (contracting unit for primary care)	Registered public and private contraction	Free choice of public provider
Dialysis cost	Free for PD as first modality, Reimbursable for HD if contraindicated to PD	Fixed fee for HD and PD Monthly extra-payment for PD And HD (some private providers)	Free for HD, PD Extra-payment for some medical supply
Medicines	Free for medicines under essential drugs list Erythropoietin through capitations	Free for medicines under essential drugs list Erythropoietin through capitations	Free for medicines under essential drugs list Erythropoietin as needed
Surgical procedures associated with dialysis (vascular access, Tenchkoff catheter insertion)	Fixed fee	Fixed fee	Free for public provider

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme. PD Peritoneal dialysis, HD Hemodialysis

[a] Data adapted from Tangcharoensathien V, Tisayaticom K, Suphanchaimat R, Vongmongkol V, Viriyathorn S, Limwattananon S. Financial risk protection of Thailand's universal health coverage: results from series of national household surveys between 1996 and 2015. *Int J Equity Health*. Sep 21 2020;19(1):163. doi:10.1186/s12939-020-01273-6

Table S2 Socioeconomic characteristics and out-of-pocket expenditures by CKD groups

Characteristics	Total	CKD15-60	CKD<15	PD	HD	P-value
Socioeconomic characteristics						
UCS (%)	540 (100)	153 (28)	108 (20)	185 (34)	94 (18)	
Patient income [a]	1549 (1221-1876)	1612 (1092-2132)	2052 (930-3174)	1259 (874-1645)	1437 (670-2204)	0.399
Total household expenditures [a]	6174 (5767-6580)	5570 (4940-6200)	7193* (6013-8372)	6414 (5735-7093)	5513 (4670-6356)	**0.023**
SSS (%)	109 (100)	24 (22)	15 (14)	11 (10)	59 (54)	
Patient income [a]	4170 (3284-5055)	7220 (4930-9509)	4304 (2322-6286)	3029* (326-5731)	3108* (2,091-4124)	**0.003**
Total household expenditures [a]	7077 (6192-7961)	7666 (6252-9080)	6951 (5374-8528)	7777 (5529-10026)	6738 (5314-8163)	0.821
CSMBS (%)	575 (100)	258 (44)	90 (16)	61 (11)	166 (29)	
Patient income [a]	6457 (5731-7183)	5891 (5152-6630)	5627 (4190-7064)	9436* (5295-13576)	6693* (5266-8120)	**0.032**
Total household expenditures [a]	9250 (8681-9819)	8682 (7905-9458)	8714 (7338-10090)	11070 (8650-13490)	9756 (8728-10784)	0.063
Out-of-pocket expenditures						
UCS (%)	540 (100)	153 (28)	108 (20)	185 (34)	94 (18)	
Out-of-pocket for medical expenditures [a]	286 (204-369)	112 (70-153)	179 (72-285)	325*[$] (245-404)	619[#] (200-1038)	**0.001**
Out-of-pocket for non-medical expenditures [a]	494 (396-591)	191 (110-271)	447* (170-725)	434*[$] (283-586)	1156*[$ #] (863-1449)	< **0.001**
Total out-of-pocket expenditures [a]	780 (645-914)	302 (205-400)	626* (311-941)	759*[$] (580-938)	1775*[$ #] (1262-2288)	< **0.001**
SSS (%)	109 (100)	24 (22)	15 (14)	11 (10)	59 (54)	
Out-of-pocket for medical expenditures [a]	348 (192-504)	57 (12-103)	232 (78-386)	775 (396-1154)	416 (148-685)	0.086
Out-of-pocket for non-medical expenditures [a]	685 (434-936)	527 (-215-1269)	224 (39-409)	1,057 (-68-2182)	797 (516-1078)	0.341
Total out-of-pocket expenditures [a]	1033 (737-1329)	584 (-158-1327)	456 (206-706)	1832 (580-3084)	1213 (842-1585)	0.054
CSMBS (%)	575 (100)	258 (44)	90 (16)	61 (11)	166 (29)	
Out-of-pocket for medical expenditures [a]	297 (243-352)	204 (121-287)	225 (142-308)	381*[$] (286-477)	451*[$ #] (329-574)	**0.001**
Out-of-pocket for non-medical expenditures [a]	834 (670-998)	368 (239-497)	383 (247-519)	863* (399-1328)	1,790*[$ #] (1323-2258)	< **0.001**
Total out-of-pocket expenditures [a]	1131 (951-1312)	572 (415-730)	608 (435-781)	1245*[$] (751-1739)	2242*[$ #] (1744-2740)	< **0.001**

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a] annual, mean (95% CI) (USD, 2021)
*P-value <0.05 vs CKD15-60, [$] P-value <0.05 vs CKD<15, [#] P-value <0.05 vs PD

Table S3 Socioeconomic, out-of-pocket (OOP) expenditures, Catastrophic Health Expenditure (CHE) and impoverishment by health insurance schemes in CKD groups

Table S3A Socioeconomic, OOP expenditures, CHE and impoverishment by health insurance schemes in CKD15-60

	Total	**UCS**	**SSS**	**CSMBS**	**P-value**
N (%)	435 (100.0)	153(35.2)	24(5.5)	258(59.3)	
Socioeconomic characteristics					
Patient income [a]	4460 (5633)	1612 (3282)	7220* (5723)	5891* (6057)	< **0.001**
Total household expenditure [a]	7531 (5684)	5570 (3977)	7666* (3535)	8682* (6361)	< **0.001**
Out-of-pocket expenditure					
OOP for medical expenditure [a]	163 (550)	112 (264)	57 (113)	204 (681)	0.160
OOP for non-medical expenditure [a]	315 (972)	191 (510)	527 (1854)	368 (1058)	0.109
Total OOP expenditures [a]	478 (1148)	302 (616)	584 (1856)	572 (1290)	0.062
CHE and impoverishment					
CHE40 [b], (95% CI)	9.9% (7.1-12.7)	8.5% (4.1-12.9)	8.3% (-2.7-19.4)	10.9% (7.1-14.6)	0.799
Pre-OOP impoverishment [c], (95% CI)	8.7% (6.1-11.4)	18.3% (12.2-24.4)	0.0%* (0.0-0.0)	3.9%* (1.5-6.2)	< **0.001**
Medical impoverishment [d], (95% CI)	5.8 (3.5-8.1)	8.0 (3.2-12.8)	4.2 (-3.8-12.2)	4.8 (2.2-7.5)	0.416
CHE and impoverishment					
CHE10 [e], (95% CI)	17.7% (14.1-21.3)	15.7% (9.9-21.4)	8.3% (-2.7-19.4)	19.8% (14.9-24.6)	0.332
Pre-OOP impoverishment [f], (95% CI)	0.9% (0.0-1.8)	1.3% (-0.5-3.1)	0.0% (0.0-0.0)	0.8% (-0.3-1.8)	0.706
Medical impoverishment [g], (95% CI)	3.2% (1.6-4.9)	4.6% (1.3-7.9)	4.2% (-3.8-12.2)	2.3% (0.5-4.2)	0.341

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, UCS, Universal Coverage Scheme. SSS, Social Security System, CSMBS, Civil Servant Monetary Benefit Scheme

[a] annual, mean (SD) (USD, 2021),

[b] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[c] The percentage of households in which total household expenditure was less than computed subsistence expenditure

[d] The percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

[e]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

[f]:The percentage of households in which total household expenditure was less than poverty line

[g]:The percentage of households in which total household expenditure after paying OOP for health, was less than poverty line

*P-value <0.05 vs UCS, $ P-value <0.05 vs SSS

Table S3B Socioeconomic, OOP expenditures, CHE and impoverishment by health insurance schemes in CKD< 15

	Total	UCS	SSS	CSMBS	P-value
N (%)	213 (100.0)	108 (50.7)	15 (7.0)	90 (42.3)	
Socioeconomic characteristics					
Patient income [a]	3721 (6494)	2052 (5949)	4304 (3916)	5627*(6955)	< **0.001**
Total household expenditure [a]	7818 (6294)	7193 (6255)	6951 (3116)	8714 (6662)	0.205
Out-of-pocket expenditure					
OOP for medical expenditure [a]	202 (484)	179 (563)	232 (304)	225 (401)	0.776
OOP for non-medical expenditure [a]	405 (1134)	447 (1471)	224 (366)	383 (660)	0.755
Total OOP expenditures [a]	606 (1310)	626 (1669)	456 (494)	608 (837)	0.895
CHE and impoverishment					
CHE40 [b], (95% CI)	7.0% (3.6-10.5)	9.3% (3.8-14.7)	0.0% (0.0-0.0)	5.6% (0.8-10.3)	0.479
Pre-OOP impoverishment [c], (95% CI)	7.5% (4.0-11.1)	11.1% (5.2-17.0)	0.0% (0.0-0.0)	4.4% (0.2-8.7)	0.152
Medical impoverishment [d], (95% CI)	3.6% (1.0-6.1)	3.1% (-0.4-6.6)	0.0% (0.0-0.0)	4.7% (0.2-9.1)	0.834
CHE and impoverishment					
CHE10 [e], (95% CI)	23.95% (18.2-29.7)	19.4% (12.0-26.9)	26.7% (4.3-49.0)	28.9% (19.5-38.3)	0.296
Pre-OOP impoverishment [f], (95% CI)	0.9% (-0.4-2.2)	0.9% (-0.9-2.7)	0.0% (0.0-0.0)	1.1% (-1.1-3.3)	1.000
Medical impoverishment [g], (95% CI)	1.9% (0.1-3.7)	3.7% (0.1-7.3)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.178

CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, UCS, Universal Coverage Scheme. SSS, Social Security System, CSMBS, Civil Servant Monetary Benefit Scheme

[a] annual, mean (SD) (USD, 2021),

[b] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[c] The percentage of households in which total household expenditure was less than computed subsistence expenditure

[d] The percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

[e]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

[f]:The percentage of households in which total household expenditure was less than poverty line

[g]:The percentage of households in which total household expenditure after paying OOP for health, was less than poverty line; *P-value <0.05 vs UCS, $ P-value <0.05 vs SSS

Table S3C Socioeconomic, OOP expenditures, CHE and impoverishment by health insurance schemes in PD

	Total	UCS	SSS	CSMBS	P-value
N (%)	257 (100.0)	185 (72.0)	11 (4.3)	61 (23.7)	
Socioeconomic characteristics					
Patient income [a]	3276 (9041)	1259 (2674)	3029 (4573)	9436*[$] (16499)	< **0.001**
Total household expenditure [a]	7577 (6497)	6414 (4712)	7777 (3805)	11070* (9643)	< **0.001**
Out-of-pocket expenditure					
OOP for medical expenditure [a]	357 (525)	325 (549)	775* (642)	381*[$] (379)	**0.019**
OOP for non-medical expenditure [a]	563 (1336)	434 (1054)	1057 (1903)	863*(1850)	**0.042**
Total OOP expenditure [a]	920 (1508)	759 (1243)	1832 (2119)	1245*(1968)	**0.011**
CHE and impoverishment					
CHE40 [b], (95% CI)	22.2% (17.1-27.3)	19.5% (13.8-25.2)	54.5%* (25.1-84.0)	24.6% (13.8-35.4)	**0.027**
Pre-OOP impoverishment [c], (95% CI)	12.8% (8.8-16.9)	15.7% (10.4-20.9)	9.1% (-7.9-26.1)	4.9% (-0.5-10.3)	0.074
Medical impoverishment [d], (95% CI)	9.8% (5.9-13.7)	11.5% (6.5-16.6)	0.0% (0.0-0.0)	6.9% (0.4-13.4)	0.531
CHE and impoverishment					
CHE10 [e], (95% CI)	42.4% (36.4-48.5)	40.5% (33.5-47.6)	72.7% (46.4-99.0)	42.6% (30.2-55.0)	0.126
Pre-OOP impoverishment [f], (95% CI)	1.6 % (0.0-3.1)	2.2% (0.1-4.3)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.643
Medical impoverishment [g], (95% CI)	3.5 % (1.3-5.7)	3.8% (1.0-6.5)	0.0% (0.0-0.0)	3.3% (-1.2-7.7)	1.000

PD Peritoneal dialysis, UCS, Universal Coverage Scheme. SSS, Social Security System, CSMBS, Civil Servant Monetary Benefit Scheme
[a] annual, mean (SD) (USD, 2021),
[b] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay
[c] The percentage of households in which total household expenditure was less than computed subsistence expenditure
[d] The percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure
[e]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure
[f]:The percentage of households in which total household expenditure was less than poverty line
[g]:The percentage of households in which total household expenditure after paying OOP for health, was less than poverty line
*P-value <0.05 vs UCS, [$] P-value <0.05 vs SSS

Table S3D Socioeconomic, OOP expenditures, CHE and impoverishment by health insurance schemes in HD

	Total	UCS	SSS	CSMBS	P-value

N (%)	319 (100.0)	94 (29.5)	59 (18.5)	166 (52.0)	
Socioeconomic characteristics					
Patient income [a]	4481 (7641)	1437 (3793)	3108* (3984)	6693*[$] (9379)	< **0.001**
Total household expenditure [a]	7948 (6182)	5513 (4172)	6738 (5582)	9756*[$] (6760)	< **0.001**
Out-of-pocket expenditure					
OOP for medical expenditure [a]	494 (1342)	619 (2072)	416 (1052)	451 (805)	0.555
OOP for non-medical expenditure [a]	1420 (2429)	1156 (1450)	797 (1101)	1790*[$] (3073)	**0.012**
Total OOP expenditures [a]	1914 (2825)	1775 (2539)	1213 (1455)	2242*[$] (3273)	**0.047**
CHE and impoverishment					
CHE40 [b], (95% CI)	40.8% (35.4-46.1)	50.0% (39.9-60.1)	32.2% (20.3-44.1)	38.6% (31.2-46.0)	0.070
Pre-OOP impoverishment [c], (95% CI)	8.5% (5.4-11.5)	19.1% (11.2-27.1)	8.5% (1.4-15.6)	2.4%* (0.1-4.7)	< **0.001**
Medical impoverishment [d], (95% CI)	20.2% (15.6-24.8)	31.6% (21.1-42.0)	24.1% (12.7-35.5)	13.6%* (8.3-18.9)	**0.004**
CHE and impoverishment					
CHE10 [e], (95% CI)	66.1 (61.0-71.3)	67.0% (57.5-76.5)	62.7 (50.4-75.1)	66.9 (59.7-74.0)	0.822
Pre-OOP impoverishment [f], (95% CI)	1.3 % (0.0-2.5)	3.2% (-0.4-6.7)	1.7% (-1.6-5.0)	0.0 % (0.0-0.0)	0.065
Medical impoverishment [g], (95% CI)	11.0% (7.5-14.4)	20.2% (12.1-28.3)	10.2% (2.5-17.9)	6.0%* (2.4-9.6)	**0.003**

HD hemodialysis, UCS, Universal Coverage Scheme. SSS, Social Security System, CSMBS, Civil Servant Monetary Benefit Scheme
[a] annual, mean (SD) (USD, 2021)
[b] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay
[c] The percentage of households in which total household expenditure was less than computed subsistence expenditure
[d] The percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure
[e]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure
[f]:The percentage of households in which total household expenditure was less than poverty line
[g]:The percentage of households in which total household expenditure after paying OOP for health, was less than poverty line
*P-value <0.05 vs UCS, [$] P-value <0.05 vs SSS

Table S4 Out-of-pocket expenditure as the percentage of total out-of-pocket expenditures for health

CKD groups	**CKD15-60(%)**			**CKD<15(%)**			**PD(%)**			**HD(%)**		
Health insurance schemes	**UCS**	**SSS**	**CSMBS**	**UCS**	**SSS**	**CSMBS**	**UCS**	**SSS**	**CSMBS**	**UCS**	**SSS**	**CSMBS**
Out-of-pocket for medical costs	36.9	9.8	35.7	28.5	50.8	37.0	42.8	42.3	30.6	34.8	34.4	20.1
Out-of-pocket for medical costs at OPD study hospital	11.3	0.0	7.9	10.1	28.6	13.4	30.7	20.7	19.4	9.8	12.1	7.3
Out-of-pocket for medical costs at OPD other hospital	2.7	0.0	8.2	1.4	6.1	4.2	0.7	5.4	1.7	23.3	12.3	3.6
Out-of-pocket for medical costs at IPD	11.7	0.0	8.8	13.9	11.5	6.7	3.4	3.7	1.0	0.6	7.8	4.5

Out-of-pocket for medical costs outside Hospital	11.2	9.8	10.8	3.2	4.6	12.7	8.0	12.5	8.5	1.1	2.2	4.7
Out-of-pocket for non-medical costs	63.1	90.2	64.3	71.5	49.2	63.0	57.2	57.7	69.4	65.2	65.6	79.9
Food cost at OPD study hospital	4.7	1.7	2.4	4.1	3.4	2.6	2.7	2.2	2.7	2.4	3.3	7.7
Food cost at OPD other hospital	0.3	0.0	0.2	0.3	0.4	0.2	0.2	0.1	0.0	2.7	2.3	1.6
Food cost at IPD	2.5	0.0	1.5	1.3	5.0	0.7	1.0	0.0	1.0	0.4	0.2	0.2
Travel cost at OPD study hospital	25.7	7.5	22.3	33.7	18.3	32.0	22.7	7.7	21.8	26.7	28.5	32.1
Travel cost at OPD other hospital	4.7	0.2	1.8	1.2	20.2	3.5	4.3	6.9	0.5	21.3	18.0	11.5
Travel cost at IPD	4.2	0.6	0.9	7.1	1.9	2.4	2.0	0.0	0.6	1.3	0.6	0.4
Accommodation cost OPD study hospital	0.2	0.0	0.7	0.0	0.0	4.5	1.7	0.0	2.3	0.0	0.0	0.9
Accommodation cost OPD other hospital	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	0.0
House improvement	11.9	62.8	21.1	16.8	0.0	14.1	12.5	10.1	23.4	0.2	10.0	6.6
Formal caregiver	8.9	17.4	13.4	6.9	0.0	3.0	10.1	30.3	17.1	10.2	2.5	18.9

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme
OPD outpatient department, IPD inpatient department
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

Table S5 Socioeconomic status quintiles-specific proportion of Catastrophic Health Expenditure (CHE)

Table S5A Socioeconomic status quintiles-specific proportion of CHE in UCS

Quintiles of socioeconomic status	**Total** (95 % CI)	**1** (95% CI)	**2** (95% CI)	**3** (95% CI)	**4** (95% CI)	**5** (95% CI)	**P-value**
CKD15-60 (N=153)							
CHE40 [a]	8.5 % (4.1 - 12.9)	19.4% (6.5-32.4)	11.1% (-0.7; 23.0)	6.2% (-2.1-14.6)	3.1% (-2.9-9.2)	0.0% (0.0-0.0)	0.051
CHE10 [b]	15.7 % (9.9 - 21.4)	33.3% (17.9-48.7)	22.2% (6.5-37.9)	12.5% (1.0-24.0)	6.2% (-2.1-14.6)	0.0% (0.0-0.0)	**0.002**
CKD<15 (N=108)							
CHE40 [a]	9.3 % (3.8 - 14.7)	31.2% (8.5-54.0)	4.3% (-4.0; 12.7)	7.7% (-2.6-17.9)	0.0% (0.0-0.0)	6.9% (-2.3-16.1)	0.047
CHE10 [b]	19.4 % (12.0- 26.9)	31.2% (8.5-54.0)	17.4% (1.9-32.9)	23.1% (6.9-39.3)	0.0% (0.0-0.0)	20.7% (5.9-35.4)	0.230
PD (N=185)							
CHE40 [a]	19.5 % (13.8- 25.2)	31.4% (16.0-46.8)	25.6% (11.9-39.3)	12.5% (1.0-24.0)	14.3% (3.7-24.9)	13.5% (2.5-24.5)	0.176
CHE10 [b]	40.5 % (33.5-	51.4% (34.9-68.0)	41.0% (25.6-56.5)	28.1% (12.5-43.7)	45.2% (30.2-60.3)	35.1% (19.8-50.5)	0.336

	47.6)						
HD (N=94)							
CHE40 [a]	50.0% (39.9-60.1)	81.8% (65.7-97.9)	66.7% (44.9-88.4)	50.0% (26.9-73.1)	25.0% (6.0-44.0)	18.8% (-0.4-37.9)	**<0.001**
CHE10 [b]	67.0% (57.5-76.5)	90.9% (78.9-102.9)	72.2% (51.5-92.9)	61.1% (38.6-83.6)	60.0% (38.5-81.5)	43.8% (19.4-68.1)	**0.024**

UCS, Universal Coverage Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay
[b]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

Table S5B Socioeconomic status quintiles-specific proportion of CHE in SSS

Quintiles of socioeconomic status	**Total** (95% CI)	**1** (95% CI)	**2** (95% CI)	**3** (95% CI)	**4** (95% CI)	**5** (95% CI)	**P-value**
CKD15-60 (N=24)							
CHE40 [a]	8.3% (-2.7-19.4)	0.0% (0.0- 0.0)	0.0% (0.0-0.0)	16.7% (-13.2-46.5)	14.3% (-11.6-40.2)	0.0% (0.0-0.0)	1.000
CHE10 [b]	8.3% (-2.7-19.4)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	16.7% (-13.2-46.5)	14.3% (-11.6-40.2)	0.0% (0.0-0.0)	1.000
CKD<15 (N=15)							
CHE40 [a]	0.0%	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0%	-

	(0.0-0.0)					(0.0-0.0)	
CHE10 [b]	26.7% (4.3-49.0)	0.0% (0.0-0.0)	50.0% (1.0-99.0)	25.0% (-17.4-67.4)	0.0% (0.0-0.0)	33.3% (-20.0-86.7)	0.859
PD (N=11)							
CHE40 [a]	54.5% (25.1-84.0)	100.0% (100.0-100.0)	66.7% (13.3-120.0)	100.0% (100.0-100.0)	50.0% (-19.31-19.3)	25.0% (-17.4-67.4)	0.766
CHE10 [b]	72.7% (46.4-99.0)	100.0% (100.0-100.0)	100.0% (100.0-100.0)	100.0% (100.0-100.0)	50.0% (-19.3-119.3)	50.0% (1.0-99.0)	0.745
HD (N=59)							
CHE40 [a]	32.2% (20.3-44.1)	62.5% (38.8-86.2)	25.0% (0.5-49.5)	27.3% (1.0-53.6)	9.1% (-7.9-26.1)	22.2% (-4.9-49.4)	**0.046**
CHE10 [b]	62.7% (50.4-75.1)	81.2% (62.1-100.4)	50.0% (21.7-78.3)	72.7% (46.4-99.0)	36.4% (7.9-64.8)	66.7% (35.9-97.5)	0.144

SSS, Social Security System

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis

[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

[b]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

Table S5C Socioeconomic status quintiles-specific proportion of CHE in CSMBS

Quintiles of socioeconomic Status	**Total** (95 % CI)	**1** (95% CI)	**2** (95% CI)	**3** (95% CI)	**4** (95% CI)	**5** (95% CI)	**P-value**
CKD15-60 (N=258)							
CHE40 [a]	10.9 % (7.1-14.6)	17.6% (7.2-28.1)	20.3% (10.1-30.6)	5.1% (-0.5-10.7)	4.0% (-1.4-9.4)	5.1% (-1.8-12.1)	**0.010**
CHE10 [b]	19.8 % (14. 9-24.6)	29.4% (16.9-41.9)	30.5% (18.8-42.3)	16.9% (7.4-26.5)	12.0% (3.0-21.0)	5.1% (-1.8-12.1)	**0.004**
CKD<15 (N=90)							
CHE40 [a]	5.6 % (0.8-10.3)	16.7% (1.8-31.6)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	6.2% (-5.6-18.1)	0.0% (0.0-0.0)	0.079
CHE10 [b]	28.9 % (19. 5-38.3)	45.8% (25.9-65.8)	21.4% (-0.1-42.9)	23.5% (3.4-43.7)	18.8% (-0.4-37.9)	26.3% (6.5-46.1)	0.360
PD (N=61)							
CHE40 [a]	24.6 % (13. 8-35.4)	70.0% (41.6-98.4)	36.4% (7.9-64.8)	23.1% (0.2-46.0)	0.0% (0.0-0.0)	5.6% (-5.0-16.1)	**0.001**
CHE10 [b]	42.6 % (30. 2-55.0)	90.0% (71.4-108.6)	45.5% (16.0-74.9)	38.5% (12.0-64.9)	0.0% (0.0-0.0)	38.9% (16.4-61.4)	**0.002**
HD (N=166)							
CHE40 [a]	38.6 %	73.3% (57.5-89.2)	48.4% (30.8-66.0)	44.1% (27.4-60.8)	18.8% (5.2-32.3)	15.4% (4.1-26.7)	**<0.001**

	(31.2-46.0)						
CHE10 [b]	66.9% (59.7-74.0)	76.7% (61.5-91.8)	71.0% (55.0-86.9)	70.6% (55.3-85.9)	56.2% (39.1-73.4)	61.5% (46.3-76.8)	0.440

CSMBS, Civil Servant Monetary Benefit Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay
[b]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure

Table S6 Proportion of Catastrophic Health Expenditure (CHE10) and impoverishment using poverty line by CKD groups

	Total (95% CI)	**CKD15-60** (95% CI)	**CKD<15** (95% CI)	**PD** (95% CI)	**HD** (95% CI)	**P-value**
CHE10 [a]						
UCS	33.9% (29.9-37.9)	15.7% (9.9-21.4)	19.4% (12.0-26.9)	40.5%*$ (33.5-47.6)	67.0%*$# (57.5-76.5)	**<0.001**
SSS	46.8% (37.4-56.2)	8.3% (-2.7-19.4)	26.7% (4.3-49.0)	72.7%*$ (46.4-99.0)	62.7% *$ (50.4-75.1)	**<0.001**
CSMBS	37.2% (33.3-41.2)	19.8% (14.9-24.6)	28.9% (19.5-38.3)	42.6%*$ (30.2-55.0)	66.9%*$# (59.7-74.0)	**<0.001**
Medical impoverishment UCS						
Pre-out-of-pocket impoverishment [b]	1.9% (0.7-3.0)	1.3% (-0.5-3.1)	0.9% (-0.9-2.7)	2.2% (0.1-4.3)	3.2% (-0.4-6.7)	0.643

					20.2% *$ #	< **0.001**
Medical impoverishment [c]	6.9% (4.7-9.0)	4.6% (1.3-7.9)	3.7% (0.1-7.3)	3.8%$ (1.0-6.5)	(12.1-28.3)	
SSS						
Pre-out-of-pocket impoverishment [b]	0.9% (-0.9-2.7)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	1.7% (-1.6-5.0)	1.000
Medical impoverishment [c]	6.4% (1.8-11.0)	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	10.2% (2.5-17.9)	0.591
CSMBS						
Pre-out-of-pocket impoverishment [b]	0.5% (-0.1-1.1)	0.8% (-0.3-1.8)	1.1% (-1.1-3.3)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.591
Medical impoverishment [c]	3.1% (1.7-4.6)	2.3% (0.5-4.2)	0.0% (0.0-0.0)	3.3% (-1.2-7.7)	6.0%*$ # (2.4-9.6)	0.038

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a]:The percentage of households in which out-of-pocket payments for health care was more than 10 % of households' total consumption expenditure
[b]:The percentage of households in which total household expenditure was less than poverty line
[c]:The percentage of households in which total household expenditure after paying OOP for health, was less than poverty line
*P-value <0.05 vs CKD15-60, $ P-value <0.05 vs CKD<15, # P-value <0.05 vs PD

Table S7 Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment

Table S7A Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment in UCS

Quintiles of socioeconomic status	**Total** (95% CI)	**1** (95% CI)	**2** (95% CI)	**3** (95% CI)	**4** (95% CI)	**5** (95% CI)	**P-value**
CKD15-60 (N=153)							
Pre-out-of-pocket impoverishment [a]	18.3% (12.2-24.4)	77.8% (64.2-91.4)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	< **0.001**
Medical impoverishment [b]	8.0% (3.2-12.8)	50.0% (15.4-84.6)	14.8% (1.4-28.2)	6.2% (-2.1-14.6)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	< **0.001**
Pre-out-of-pocket impoverishment [c]	1.3% (-0.5-3.1)	5.6% (-1.9-13.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.198
Medical impoverishment [d]	4.6% (1.3-7.9)	11.1% (0.8-21.4)	3.7% (-3.4-10.8)	6.2% (-2.1-14.6)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.161
CKD<15 (N=108)							
Pre-out-of-pocket impoverishment [a]	11.1% (5.2-17.0)	75.0% (53.8-96.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	< **0.001**
Medical impoverishment [b]	3.1% (-0.4-6.6)	50.0% (1.0-99.0)	0.0% (0.0-0.0)	3.8% (-3.5-11.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.003**
Pre-out-of-pocket impoverishment [c]	0.9% (-0.9-2.7)	6.2% (-5.6-18.1)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.278
Medical impoverishment [d]	3.7% (0.1-7.3)	18.8% (-0.4-37.9)	0.0% (0.0-0.0)	3.8% (-3.5-11.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.017**
PD (N=185)							
Pre-out-of-pocket impoverishment [a]	15.7%	82.9%	0.0%	0.0%	0.0%	0.0%	< **0.001**

	(10.4-20.9)	(70.4-95.3)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	
Medical impoverishment [b]	11.5% (6.5-16.6)	66.7% (28.9-104.4)	23.1% (9.9-36.3)	3.1% (-2.9-9.2)	4.8% (-1.7-11.2)	5.4% (-1.9-12.7)	< **0.001**
Pre-out-of-pocket impoverishment [c]	2.2% (0.1-4.3)	11.4% (0.9-22.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.002**
Medical impoverishment [d]	3.8% (1.0-6.5)	14.3% (2.7-25.9)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	2.4% (-2.2-7.0)	2.7% (-2.5-7.9)	**0.011**
HD (N=94)							
Pre-out-of-pocket impoverishment [a]	19.1% (11.2-27.1)	81.8% (65.7-97.9)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	< **0.001**
Medical impoverishment [b]	31.6% (21.1-42.0)	100.0% (100.0-100.0)	61.1% (38.6-83.6)	27.8% (7.1-48.5)	15.0% (-0.6-30.6)	6.2% (-5.6-18.1)	< **0.001**
Pre-out-of-pocket impoverishment [c]	3.2% (-0.4-6.7)	13.6% (-0.7-28.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.036**
Medical impoverishment [d]	20.2% (12.1-28.3)	31.8% (12.4-51.3)	33.3% (11.6-55.1)	16.7% (-0.5-33.9)	10.0% (-3.1-23.1)	6.2% (-5.6-18.1)	0.145

UCS, Universal Coverage Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure
[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure
[c]:the percentage of households in which total household expenditure was less than poverty line
[d]:the percentage of households in which total household expenditure after paying OOP for health, was less than poverty line

Table S7B Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment in SSS

Quintiles of socioeconomic status	**Total** (95% CI)	**1** (95% CI)	**2** (95% CI)	**3** (95% CI)	**4** (95% CI)	**5** (95% CI)	**P-value**
CKD15-60 (N=24)							
Pre-out-of-pocket impoverishment [a]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [b]	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	16.7% (-13.2-46.5)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.708
Pre-out-of-pocket impoverishment [c]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [d]	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	16.7% (-13.2-46.5)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.708
CKD<15(N=15)							
Pre-out-of-pocket impoverishment [a]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [b]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Pre-out-of-pocket impoverishment [c]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [d]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
PD (N=11)							
Pre-out-of-pocket impoverishment [a]	0.09%[e]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [b]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Pre-out-of-pocket impoverishment [c]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [d]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
HD (N=59)							
Pre-out-of-pocket impoverishment [a]	8.5% (1.4-15.6)	31.2% (8.5-54.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.007**
Medical impoverishment [b]	24.1% (12.7-35.5)	54.5% (25.1-84.0)	16.7% (-4.4-37.8)	27.3% (1.0-53.6)	9.1% (-7.9-26.1)	11.1% (-9.4-31.6)	0.126
Pre-out-of-pocket impoverishment [c]	1.7% (-1.6-5.0)	6.2% (-5.6-18.1)	0.0% (0.0-.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	1.000
Medical impoverishment [d]	10.2% (2.5-17.9)	25.0% (3.8-46.2)	0.0% (0.0-0.0)	9.1% (-7.9-26.1)	9.1% (-7.9-26.1)	0.0% (0.0-0.0)	0.217

SSS, Social Security System, CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2,
PD peritoneal dialysis, HD hemodialysis
[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure
[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure
[c]:the percentage of households in which total household expenditure was less than poverty line
[d]:the percentage of households in which total household expenditure after paying OOP for health, was less than poverty line, [e] 1 patient with pre-OOP impoverishment

Table S7C Socioeconomic status quintiles-specific proportion of pre-out-of-pocket and impoverishment in CSMBS

Quintiles of socioeconomic status	**Total** (95% CI)	**1** (95% CI)	**2** (95% CI)	**3** (95% CI)	**4** (95% CI)	**5** (95% CI)	**P-value**
CKD15-60 (N=258)							
Pre-out-of-pocket impoverishment [a]	3.9% (1.5-6.2)	19.6% (8.7-30.5)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	< **0.001**
Medical impoverishment [b]	4.8% (2.2-7.5)	12.2% (2.2-22.2)	5.1% (-0.5-10.7)	3.4% (-1.2-8.0)	4.0% (-1.4-9.4)	0.0% (0.0-0.0)	0.167
Pre-out-of-pocket impoverishment [c]	0.8% (-0.3-1.8)	3.9% (-1.4-9.2)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.098
Medical impoverishment [d]	2.3% (0.5-4.2)	2.0% (-1.8-5.8)	3.4% (-1.2-8.0)	3.4% (-1.2-8.0)	2.0% (-1.9-5.9)	0.0% (0.0-0.0)	0.904
CKD<15 (N=90)							
Pre-out-of-pocket impoverishment [a]	4.4% (0.2-8.7)	16.7% (1.8-31.6)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.029**
Medical impoverishment [b]	4.7% (0.2-9.1)	20.0% (2.5-37.5)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.007**
Pre-out-of-pocket impoverishment [c]	1.1% (-1.1-3.3)	4.2% (-3.8-12.2)	0.0% (0.0-0.0)	0.0 % (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	1.000
Medical impoverishment [d]	0.0 % (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
PD (N=61)							
Pre-out-of-pocket impoverishment [a]	4.9% (-0.5-10.3)	30.0% (1.6-58.4)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	**0.006**
Medical impoverishment [b]	6.9 % (0.4-13.4)	28.6% (-4.9-62.0)	9.1 (-7.9-26.1)	7.7 (-6.8-22.2)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.090
Pre-out-of-pocket impoverishment [c]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [d]	3.3% (-1.2-7.7)	10.0% (-8.6-28.6)	9.1% (-7.9-26.1)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.280
HD (N=166)							
Pre-out-of-pocket impoverishment [a]	2.4% (0.1-4.7)	13.3% (1.2-25.5)	0.0% (0.0-0.0)	0.0% (0.0; 0.0)	0.0% (0.0; 0.0)	0.0% (0.0-0.0)	**0.001**
Medical impoverishment [b]	13.6% (8.3-18.9)	50.0% (30.8-69.2)	12.9% (1.1-24.7)	8.8% (-0.7; 18.4)	0.0% (0.0; 0.0)	5.1% (-1.8-12.1)	< **0.001**
Pre-out-of-pocket impoverishment [c]	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0-0.0)	0.0% (0.0; 0.0)	0.0% (0.0; 0.0)	0.0% (0.0-0.0)	-
Medical impoverishment [d]	6.0% (2.4-9.6)	16.7% (3.3-30.0)	3.2% (-3.0-9.4)	5.9% (-2.0; 13.8)	0.0% (0.0; 0.0)	5.1% (-1.8-12.1)	0.095

CSMBS, Civil Servant Monetary Benefit Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure
[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure
[c]:the percentage of households in which total household expenditure was less than poverty line
[d]:the percentage of households in which total household expenditure after paying OOP for health, was less than poverty line

Table S8 Multivariable adjusted probability of Catastrophic Health Expenditure (CHE)

Variables	CHE40 [a,c]		CHE10 [b,c]	
	Average Probability	95% CI	Average Probability	95% CI
CKD15-60#UCS	0.076	0.042-0.109	0.149	0.116-0.183
CKD15-60#SSS	0.120	-0.013-0.252	0.112	-0.044-0.267
CKD15-60#CSMBS	0.096	0.059-0.134	0.183	0.130-0.236
CKD<15#UCS	0.088	0.052-0.125	0.187	0.126-0.248
CKD<15#SSS	.	.	0.306	0.159-0.453
CKD<15#CSMBS	0.049	0.003-0.094	0.266	0.142-0.390
PD#UCS	0.215	0.139-0.290	0.432	0.284-0.581
PD#SSS	0.582	0.319-0.845	0.753	0.547-0.959
PD#CSMBS	0.272	0.130-0.415	0.432	0.242-0.622
HD#UCS	0.527	0.366-0.687	0.694	0.588-0.800
HD#SSS	0.373	0.238-0.507	0.661	0.566-0.757
HD#CSMBS	0.403	0.284-0.522	0.668	0.588-0.748

UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2,

PD peritoneal dialysis, HD hemodialysis

[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay.

[b]:The percentage of households in which out-of-pocket payments for health care was more than 10% of households' total consumption expenditure

[c] Adjusted with age, sex, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members

95% CI, 95% Confidence Interval

Table S9 Probability of incurring Catastrophic Health Expenditure (CHE) by regions from the modeling

Variables	CHE40 [a,c]		CHE10 [b,c]	
	Average Probability	95% CI	Average Probability	95% CI
Regions				
Central	0.297	0.231- 0.363	0.434	0.366 - 0.502
North	0.150	0.114 - 0.185	0.304	0.260 - 0.348
Northeast	0.228	0.164 - 0.291	0.363	0.307 - 0.420
East	0.122	0.103 - 0.141	0.313	0.283 - 0.343
South	0.178	0.127 - 0.230	0.377	0.356 - 0.397

[a]:The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay.

[b]:The percentage of households in which out-of-pocket payments for health care was more than 10% of households' total consumption expenditure

[c] Adjusted with age, sex, CKD groups, health insurance scheme, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members
95% CI, 95% Confidence Interval

Figure S1 Flow of study

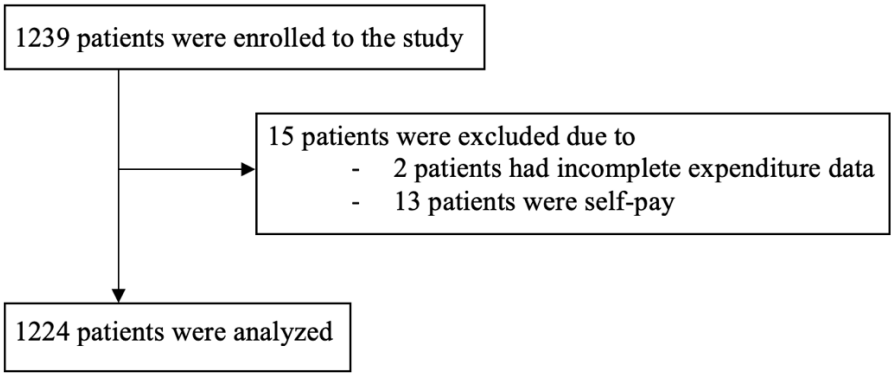
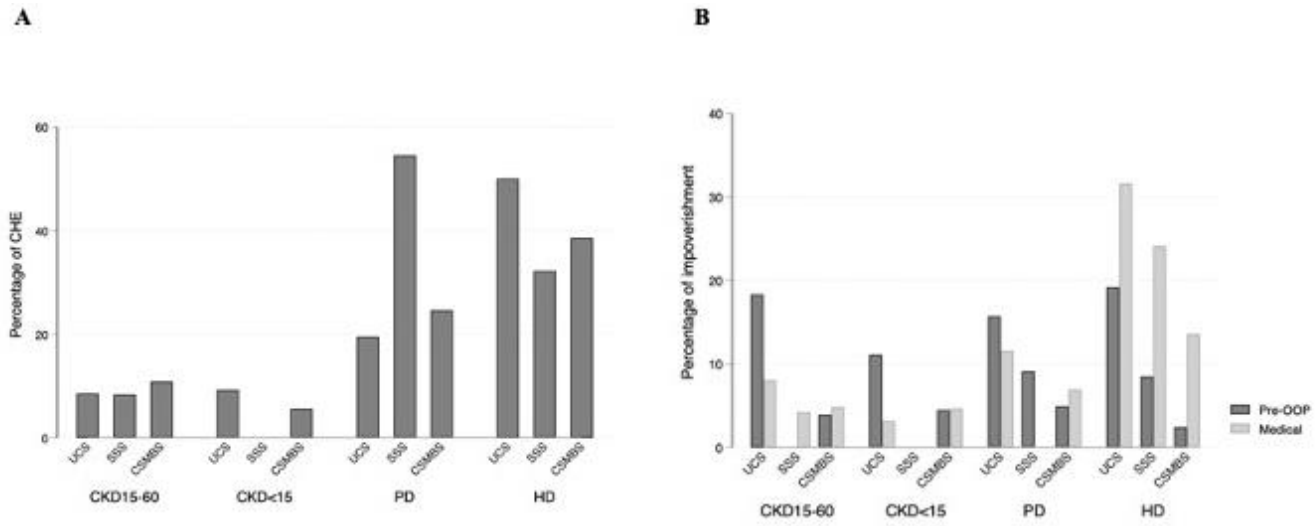
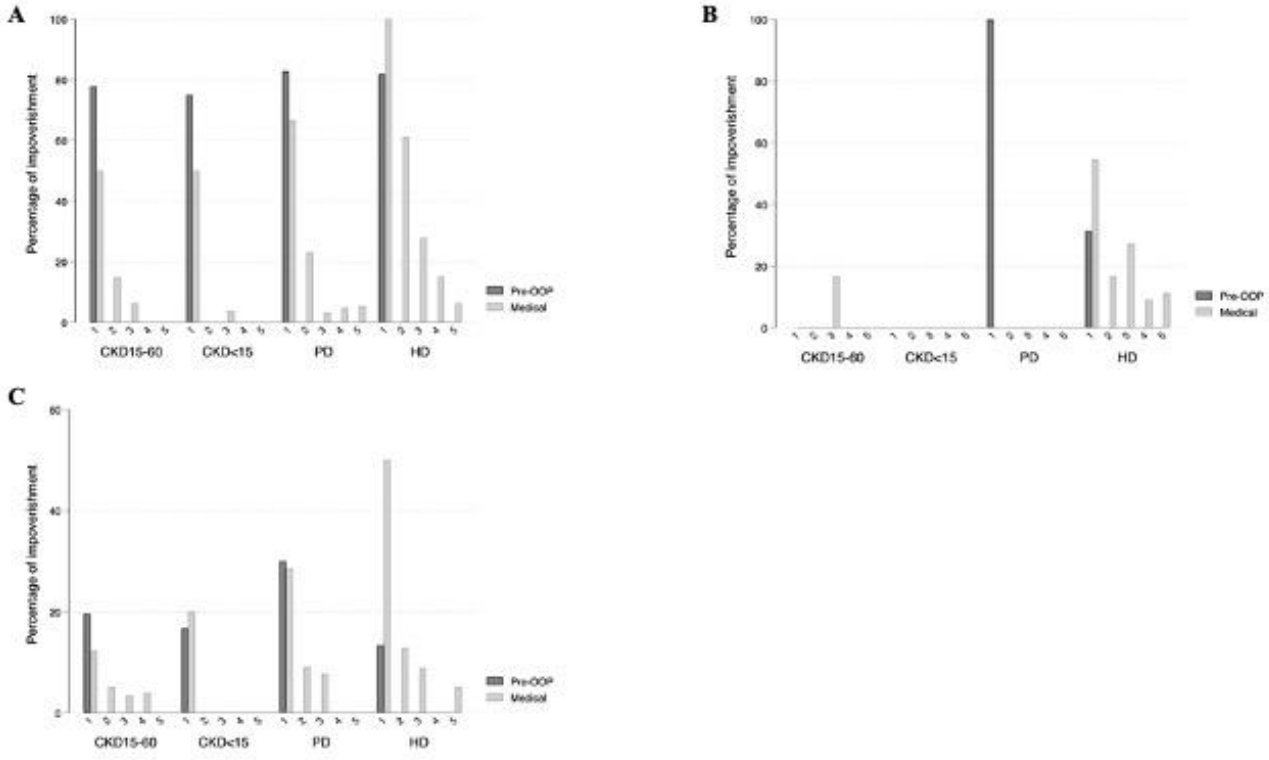


Figure S2 Proportion of Catastrophic Health Expenditure (CHE40) [a] and impoverishment [b,c] according to CKD groups and health insurance schemes. (A) CHE40, (B) pre-OOP and medical impoverishment



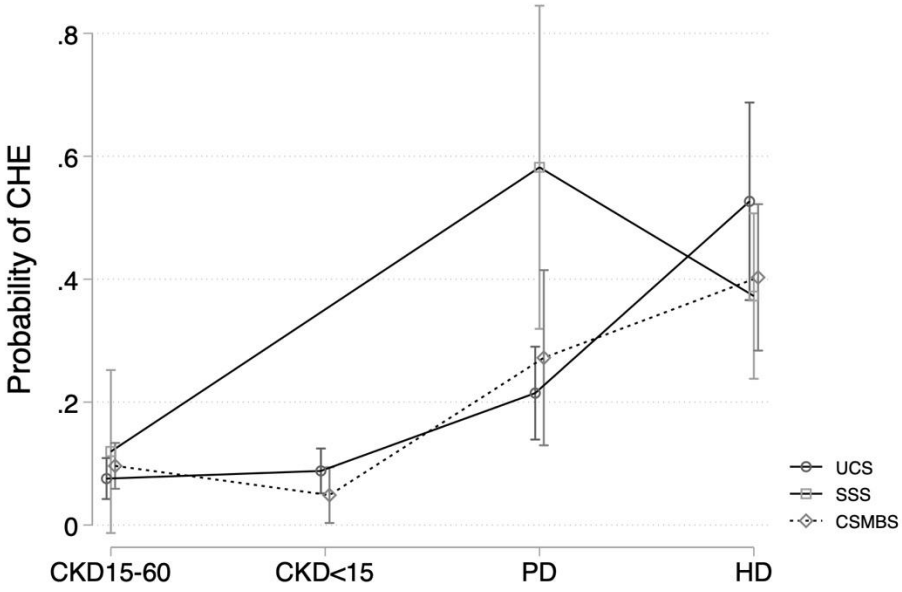
UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay
[b] The percentage of households in which total household expenditure was less than computed subsistence expenditure
[c] The percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

Figure S3 Socioeconomic status quintiles-specific proportion of pre-out-of-pocket (pre-OOP)[a] and medical impoverishment[b].
(A) UCS, (B) SSS, (C) CSMBS.



UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme
CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2, PD peritoneal dialysis, HD hemodialysis
[a]:the percentage of households in which total household expenditure was less than computed subsistence expenditure
[b]:the percentage of households in which total household expenditure after paying OOP for health, was less than computed subsistence expenditure

Figure S4 Adjusted Probability of Catastrophic Health Expenditure (CHE40)[a] by health insurance schemes and CKD groups



UCS, Universal Coverage Scheme. SSS, Social Security System. CSMBS, Civil Servant Monetary Benefit Scheme

CKD15-60 chronic kidney disease with eGFR 15-60 ml/min/1.73m^2, CKD<15 chronic kidney disease with eGFR<15 ml/min/1.73m^2,

PD peritoneal dialysis, HD hemodialysis

[a] The percentage of households in which out-of-pocket payments for health care was at least 40% of household capacity to pay

Adjusted with age, sex, diabetes, hypertension, cardiovascular disease, dyslipidemia, annual patient income, number of household members

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