Faculty of Medicine and Health Sciences

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Evaluation of performance of diabetes care initiatives implemented in Cambodia

PhD thesis submitted for the degree of doctor of medical sciences at the University of Antwerp to be defended by Vannarath TE

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Evaluatie van de prestaties van diabeteszorginitiatieven geïmplementeerd in Cambodja

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Contents

List of Abbreviations

ASEAN	Association of Southeast Asian Nations
CCM	Chronic care model
CPA	Complementary Package of Activities
CVDs	Cardiovascular diseases
DCIs	Diabetes care initiatives
FBG	Fasting blood glucose
HbA1c	Glycated hemoglobin
HCMC	Health Center Management Committee
HEF	Health equity fund
H-EQIP	Health equity and quality improvement project
ICCC	Innovative care for chronic conditions
ICP	Integrated care package
LMICs	Low-and middle-income countries
MPA	Minimum Package of Activities
NCDs	Noncommunicable diseases
NSSF	National Social Security Fund
OD	Operational health district
PHC	Primary health care
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
T2D	Type 2 diabetes
WHO	World Health Organisation
WHO PEN	World Health Organisation package of essential noncommunicable disease interventions

Samenvatting

Diabetes type 2 (T2D) is een van de belangrijkste risicofactoren voor hart- en vaatziekten (HVZ), verantwoordelijk voor bijna een derde van de totale mondiale sterfgevallen in 2021. Cambodja is ook zwaar getroffen door de T2D epidemie. De ongeneeslijke aard van T2D, samen met de chroniciteit en de stille progressie ervan, vereist dat de aandoening zo vroeg mogelijk wordt gediagnosticeerd en op regelmatige basis goed en snel wordt behandeld om complicaties te voorkomen of uit te stellen. Het management van T2D in Cambodja is echter beperkt. Om dit te verbeteren, zijn er in het Cambodjaanse openbare gezondheidszorgsysteem drie belangrijke Diabetes Care Initiatives (DCI's) die momenteel worden opgeschaald: een ziekenhuis-gebaseerd model; een primair gezondheidzorgmodel en een gemeenschap-geïnitieerd model) . Het doel van dit doctoraatsonderzoek is om systematisch de prestaties van de drie DCI's te evalueren in hun capaciteit om T2D zorg aan de bevolking in Cambodja te geven. De thesis gaat uit van de nationale standaarden voor T2D- en hypertensie zorg in de eerstelijn. Deze sluiten nauw aan bij het Innovative Care for Chronic Condities (ICCC) framework van de Wereldgezondheidsorganisatie. De evaluaties in dit onderzoek focusen op de capaciteit van de respectievelijke DCIs om tegemoet te komen aan de noden van de populatie over het gehele zorgtraject, van screening en testen tot aan het bereiken van goede glucosewaarden bij mensen met T2D.

We maakten gebruik van mixed-methods, waarbij kwalitatieve en kwantitatieve gegevens grotendeels tegelijkertijd werden verzameld en geanalyseerd, om elkaar te informeren en op elkaar voort te bouwen . We verzamelden gegevens uit meerdere gegevensbronnen en op verschillende niveaus van het gezondheidszorgsysteem (zorggebruikers, gezondheidszorgorganisatie, en beleidsmakers) tussen 2019-2020. Op basis van de informatie uit de interviews met programmamanagers van de drie DCI's op nationaal niveau werden doelbewust vijf operationele gezondheidsdistricten (OD's) geselecteerd, gebaseerd op de beschikbaarheid van de DCI's, in combinatie of afzonderlijk, om een optimale variatie te garanderen en zo het volledige spectrum van bestaande DCI's in Cambodja te kunnen omvatten.

We hebben een review van systematische reviews uitgevoerd om zorgcomponenten en hun respectievelijke uitkomsten voor T2D te identificeren die zijn geïmplementeerd in de gezondheidszorgsystemen van de Associatie van Zuidoost-Aziatische Naties (ASEAN) om deze in kaart te brengen in het ICCC-framework. De resultaten toonden aan dat de meeste effectieve zorgcomponenten voor T2D geïmplementeerd in de zorgsystemen , zich concentreerden op zelfmanagement en het microniveau van het ICCC framework. Er komt ook toenemend bewijs voor de effectiviteit van een multidisciplinair gezondheidszorgteam, inclusief apothekers en verpleegkundigen. Dit kan verder worden versterkt door effectief gebruik van digitale interventies. Community Health Workers en'expert patiënten kunnen met de benodigde software (kennis en vaardigheden) en hardware (medische apparatuur en benodigdheden) het gezondheidszorgpersoneel ondersteunen bij het verlenen van de zorg.

We hebben de 'Cascade of Care' benadering i gebruikt om het continuüm van zorg voor mensen met T2D te beoordelen. Er werd een bevolkingsonderzoek uitgevoerd om de capaciteit van de drie DCI's te beoordelen – afzonderlijk of in combinatie met elkaar – in het diagnosticeren van mensen met T2D, hen toeleiden naar zorg, hen in zorg houden - en het behoud van optimale glucose regulatie ('onder controle'),in de geselecteerde vijf OD's. De resultaten toonden aan dat er grote gaten zijn in de effectiviteit van van T2D management, vooral in het testen van mensen en in het bereiken van goede glucoseregulatie. Van de in totaal 5.072 personen hadden 614 (12,11%) een verhoogde bloedglucose (FBG ≥126 mg/dl) en 560 (11,04%) voldeden aan de definitie van T2D (FBG ≥126 mg/dl EN HbA1c-waarde ≥6,5%) . Door de 560 individuen als vaste noemer voor de cascade van zorg te gebruiken, hebben we vastgesteld dat twee stappen in de cascade – ooit getest en onder controle – een aanzienlijk verval lieten zien.. We ontdekten tegen onze verwachtingen in dat de OD waarin alle 3 DCI in combinatie met elkaar bestonden, over alle uitkomstmaten heen de slechtste cascade vertoonde, terwijl de OD met de ziekenhuiszorg de beste cascade had. We ontdekten ook dat de onderzochte DCI's in de ODs niet exclusief verantwoordelijk waren voor het verlenen van zorg voor mensen met T2D, wat het zwakke verband tussen de aanwezigheid van de DCI's en de cascaderesultaten van elke onderzoek setting mogelijks mede verklaart. Op basis van dezelfde onderzoeksgegevens hebben we het gebruik van publieke en private gezondheidszorg geëvalueerd. De bevindingen bevestigden dat het gebruik van gezondheidszorg overwegend in de particuliere sector plaatsvond. Van de deelnemers (2.360) die in de afgelopen drie maanden minstens één keer gebruik maakten van gezondheidszorg, maakte slechts 22% gebruik van de publieke gezondheidszorg. Niettemin waren er onder de mensen die gebruik maakte van de openbare gezondheidszorg meer met T2D. We hebben ook waargenomen dat een groter gebruik van publieke gezondheidszorg onder mensen met T2D geassocieerd was met de aanwezigheid van een tegemoetkomingsfonds voor armen (Health Equity Funds) -en dat het hoger was in de OD waar ook een gemeenschaps-geïnitieerd model was. Als patienten meer gebruik van openbare gezondheidszorgfaciliteiten ging dit gepaard met een vermindering van de gezondheidszorguitgaven, vooral voor de armsten.

We analyseerden data verzameld via vragenlijsten onder personeel van gezondheidscentra, met een steekproefomvang van 1.157 (95%) van de in totaal 1.221 eerstelijnsgezondheidscentra in Cambodja. Uit de bevindingen van het zelfgerapporteerde onderzoek bleek dat slechts 223 (19%) momenteel zorg voor T2D aanbiedt. We hebben ook een diepgaande analyse uitgevoerd van de implementatie van geïntegreerde zorg voor T2D van de drie DCI's , aan de hand van een framework voor assessment van geïntegreerde zorg, dat gebaseerd is op het ICCC framework-. Uit de resultaten bleek dat alle DCI's een lage tot matige implementatie (score van 2 op 5) hadden. In de OD's waar het primair gezondheidzorg-model aanwezig was waren, waren de onderdelen s voor vroege detectie, diagnose en behandeling in de eerstelijnszorg beter geïmplementeerd; in de ODs met gemeenschap-geïnitieerd modellen was gestructureerde samenwerking en organisatie van de zorg beter geïmplementeerd. In de ODs waar meerdere DCIs naast elkaar bestonden waren er soms wel betere scores, maar er bleek geen werkelijke synergie te bestaan tussen de DCIs. Er waren geen operationele processen die de geïntegreerde zorg voor T2D zouden kunnen versterken, zoals informatiedeling of gecoördineerde van middelen. Deze

diepgaande analyse hielp verklaren waarom de ODs met co-existentie van DCI modellen niet tot betere continuüm van zorg resultaten leidde. Het weerlegde onze initiële aanname gebaseerd op het ICCCframework dat de combinatie van de drie modellen een ideale context vertegenwoordigt voor de geïntegreerde zorg voor T2D.

Over het geheel genomen was de capaciteit van DCI's om goede zorg voor mensen met T2D te bieden over het gehele zorgcontinuüm suboptimaal. Het naast elkaar bestaan van de drie DCI's is niet voldoende voor een verhoogde capaciteit, maar een goede onderlinge coördinatie zijn noodzakelijk voor de geïntegreerde zorg voor T2DCommunity Health Werkers kunnen het gezondheidszorgteam versterken bij het bieden van gezondheidseducatie en zelfmanagementondersteuning aan mensen met T2D en aan de algemene bevolking. Zij kunnen worden opgeleid om een rol te spelen als zorgcoördinator om de gestructureerde samenwerking en organisatie van de zorg te verbeteren. Het is belangrijk dat de rol van alle relevante gezondheidswerkers in de gemeenschap geformaliseerd en financieel ondersteund wordt. De capaciteit van eerstelijns gezondheidscentra moet worden versterkt als locus voor het bieden van zorgcontinuïteit voor T2D in het openbare gezondheidszorgsysteem.

Summary

Type 2 Diabetes (T2D) is one of the major risk factors for cardiovascular diseases (CVDs) accountable for almost one third of the total global deaths in 2021. Cambodia has also been severely affected by the T2D epidemic. The incurable nature of T2D, along with its chronicity and silent progression, requires the condition to be diagnosed as early as possible, and to be managed properly and promptly on a regular basis to prevent or delay complications. However, T2D management in Cambodia has been limited. In order to address this, three main Diabetes Care Initiatives (DCIs) (hospital-based, health center-based, and community-based) are being scaled up in the Cambodian public healthcare system. The aim of this PhD study is to systematically evaluate the performance of the three DCIs in providing T2D care to the population in Cambodia. It is based on the national standard operating procedure for T2D and hypertension managment in primary care, which is a reflection of the Innovative Care for Chronic Conditions (ICCC) framework endorsed by the World Health Organisation. Performance in this study refers to the capacity of the DCI implemented as part of the Cambodian health system to meet the needs of the population at risk and people with T2D, from testing to controlling their blood glucose level.

A mixed-methods research with concurrent design was employed. Qualitative data and quantitative data were collected and analysed to inform and build on each other during a similar timeframe. The study collected data from multiple sources of data and levels of the health system (population level, healthcare organisation level, and policy level) between 2019-2020. Through the stakeholder interviews with program managers of the three DCIs at the national level, five operational health districts (ODs) were purposively selected depending on availability of the DCIs, either individually or in co-existence, to ensure a maximal spread, which embodied the full spectrum of existing DCIs in Cambodia.

We conducted an umbrella review of systematic reviews to identify effective care components for T2D implemented in the health systems of Association of Southeast Asian Nations (ASEAN) and to map those care components in the ICCC framework. The results showed that most of the effective care components for T2D implemented in the health systems were centered around the patients' self-management in the micro-level of the ICCC framework. There is increasing evidence of the potential of a multidisciplinary health care team including pharmacists and nurses to effectively support patients in self-management of their conditions. This can be further strengthened by effective use of digital health interventions. Community health workers either peers or lay people—with necessary software (knowledge and skills) and hardware (medical equipment and supplies)—can support the health care staff in providing the care.

We adapted the HIV test-treat-retain cascade of care to assess the continuum of care for people living with T2D. A population-based survey was conducted to assess the performance of the three DCIs—individually or in co-existence—in diagnosing population with T2D, linking them to care, retaining them in treatment, and controlling their blood glucose in the selected five ODs. The results showed large drops in the population management of people with T2D, especially in the steps of testing people and of ensuring that people reach are 'under-control' (meaning having an

optimal HbA1c level). Of the total 5,072 individuals, 614 (12.11%) had a raised blood glucose (FBG ≥126 mg/dl) and 560 (11.04%) met the definition of having T2D (FBG ≥126 mg/dl AND HbA1c level ≥6.5%). Using the 560 individuals as the fixed denominator for the cascade of care, we observed that two bars—ever tested and being under-control—displayed a significant drop. Contrary to our initial assumptions, we found that the OD hosting the co-existence of care displayed the worst cascade across all bars, while the OD with the hospital-based care had the best cascade among the five. We also found that the DCIs under study were not exclusively responsible for the provision of T2D care in each OD. This might also explain the weak connection between presence of the DCIs and the cascade results of each study setting. Based on the same population-based survey data, we assessed usage of public and private healthcare. The findings confirmed that healthcare utilisation took place dominantly in private sector. Among the participants (2,360) using healthcare at least one in the past three months, only 22% utilised the public healthcare. Nevertheless, among the 22% who utilised the public healthcare, 72% were living with T2D. We also observed that increased use of public healthcare among those with T2D was associated with the membership of the health equity funds and the presence of community-based care in an OD. This increased use of public health facilities was found to be associated with a reduction in healthcare expenditure among the patients, especially the poorest category who benefited from the health equity fund membership.

We analysed a dataset of a self-reported survey with health center staff with the sample size of 1,157 (95%) of the total 1,221 health centers in Cambodia. The findings of the self-reported study showed that only 223 (19%) health centers currently provided T2D services at their facilities. We also conducted an in-depth analysis of the implementation of integrated care at healthcare facilities of the three DCIs. The results showed that implementation of integrated care in the five selected ODs was low to moderate (score of 2 out of 5). The presence of health center-based care was associated with better implementation of the integrated components necessary for early detection, diagnosis and treatment in primary care services, while the presence of community-based care was related to structured collaboration and organisation of care. The co-existence of care seemed to have better scores due to the combined contributions, but the co-existence did not automatically generate synergism necessary for the optimum integrated care for T2D. There was no operational support facilitating the integrated care for T2D, for instance mechanism for sharing necessary information and coordination of resources. This in-depth analysis helped to explain why the OD with co-existence of care did not lead to better continuum of care outcomes. This refutes the assumption underlying the ICCC framework that the combination of healthcare organisation and community represents an ideal context for the integrated care for T2D.

In overall, the performance of DCIs in the Cambodian public healthcare system in providing the T2D care continuum remained suboptimal. The co-existence of the three DCIs is not enough, but good implementation fidelity and coordination among them are necessary for the integrated care for T2D in primary health care of the operational district health system, according to the ICCC framework. Community health workers should support the healthcare team to provide health education and self-management support to people with T2D and communities. They can be

equipped to play a role as care coordinators to improve structured collaboration and organisation of care. It is vital that all relevant community health workers are formalised and financially supported. Health centers (primary care level) should be strengthened as a locus for the provision of care continuity for T2D in the public healthcare system.

Part 1: General Introduction

- **Chapter 1**: Overview of Diabetes Care
- **Chapter 2**: Research Methodology

Part 1: General Introduction

Chapter 1: Overview of Diabetes Care

One of the pressing global health challenges, diabetes is one of the chronic conditions directly contributing to the death of an estimated 1.5 million people worldwide in 2019—48% of the deaths due to diabetes was premature before the age of 70 [1]. In 2021, globally 1 in 10 adults aged 20-79 were living with diabetes, of which over 3 in 4 live in low-and middle-income countries (LMICs) [2]. Type 2 diabetes (T2D), which is the main focus in this thesis, is responsible for more than 90% of the total diabetes prevalence and mainly affecting adults [1]. T2D is one of the major risk factors for cardiovascular diseases (CVDs) [1] which was accountable for 32% (almost one third) of the total global deaths in 2021 [3].

According to the World Health Organisation (WHO), WHO Western Pacific and South East Asia regions were hardest hit, with 206 million (1 in 8) and 90 million (1 in 11) adults living with diabetes, respectively [2]. In both regions, over half of the adults living with diabetes were undiagnosed—53% in the Western Pacific region and 51.2% in the South East Asia region [2].

The incurable nature of T2D, along with its chronicity and silent progression, requires the condition to be diagnosed as early as possible and managed properly and promptly on a regular basis to prevent or delay complications [4]. Care for T2D does not solely rely on medical interventions provided by the healthcare professionals but also high-quality and continuous self-management [5]. Life-long continuum of care of regular and proper disease management is required to achieve care goals—prevention or delay of the complications and optimisation of quality of life—of which blood glucose control is a critical indicator [4, 6]. More robust and proactive healthcare systems are needed to achieve the care goals [4]. Nevertheless, many health systems are still reactive, episodic, fragmented, and physician-centered, rendering them less well equipped to continuously manage chronic conditions [7]. Health systems in the LMICs are usually not able to meet needs of people living with this chronic and incurable disease, and coping with resulting health complications is often an individual struggle [7-9]. A study on the health system performance of 28 LMICs in meeting needs of people with T2D confirmed that the unmet needs were large due to poor management of T2D [10]. The study also revealed that only 63.4% of those with T2D had undergone blood glucose testing [10].

In response to the increased prevalence of noncommunicable diseases (NCDs) and T2D as a part thereof and unmet needs of people, a global strategy for the prevention and control of NCDs was given a priority in the 53rd World Health Assembly In 2000 [11], and T2D has been one of the key priorities. A considerable number of strategies, action plans, and interventions have been developed, as a result. In 2002, the WHO published an Innovative Care for Chronic Conditions (ICCC) framework to serve as a roadmap for health system transformation for member states [4].

In the health goal of the Sustainable Development Goals, NCDs have been explicitly expressed as one target (target 3.4) [12]. The United Nations in 2018 revitalised the momentum through a political declaration of the third high-level meeting of the General Assembly on the prevention and control of NCDs [13]. The declaration urged all member states to accelerate their response to address the NCDs with the heading "Time to deliver". One of the important recommendations to manage the NCDs is through health system strengthening at primary health care (PHC). In response to the declaration, the WHO in the 148th session of its Executive Board affirmed the noticeable rise of T2D and the incapability of many health systems to keep pace with the increasing NCD burden [14]. The WHO also noted that between 2010 and 2019, in many member states, achievement for completing NCD indicators lagged behind those of communicable diseases and maternal and child health. If target 3.8 on achieving universal health coverage is to be realized by 2030, the strengthened health system for the management of NCDs has to be in place [14].

WHO package of essential noncommunicable disease interventions (WHO PEN) has been adopted as a central strategy to strengthen the management of NCDs at the PHC, with intent on achieving the universal health coverage [15]. The WHO PEN is intended to strengthen health systems of LMICs in response to NCD burden through integration of NCD management into the PHC based on a horizontal approach. This approach focuses on an integrated public health system for basic health services for interrelated health issues with emphasis also on prevention [16, 17]. In 2020, the latest version of WHO PEN was released claiming to incorporate additional technical guidance for integrating and scaling up essential NCD interventions into the PHC [18]. The WHO PEN limits its interventions to detection, diagnosis, treatment and care of the major NCDs or risk factors including CVDs, T2D, chronic respiratory diseases, and cancer (early diagnosis only). Protocols and tools to perform each intervention procedure have been designed to be feasible for primary care physicians and non-physician health workers in low-resource settings of LMICs.

T2D Care in Cambodia and Health System

With approximately 15.6 million population [19], Cambodia, one of the LMICs in the WHO Western Pacific region and a member state of Association of Southeast Asian Nations (ASEAN), has achieved significant economic development before the COVID pandemic, enabling the country to move from low to lower-middle income group [20, 21]. Cambodia demographic and health survey 2021-2022 showed significant reduction of under-5 mortality from 124 to 16 deaths per 1,000 live births between 2000 and 2021-22 [22]. The survey also revealed a continuing decline in fertility rate from 3.8 children per woman to 2.7 children per woman from 2000 to 2021-22 [22]. The above-mentioned trends indicate stages of demographic transition observed in most countries, leading to decline in dependency ratio which in turn increases resources for human capital formation and capital savings [23]. This demographic transition is very conducive to the potential economic growth on the condition that the working age population are healthy and productive [24]. The Royal Government of Cambodia has emphasised

the importance of health as a key role in capacity building of human resources crucial to the continued economic growth in the National Strategic Development Plan [25]. Along with the demographic transition, Cambodia has also experienced epidemiological transition towards a noticeable increase in NCDs including T2D. These demographic and epidemiological transitions have significant policy implications for social protection and healthcare system transformation because the elderly are vulnerable members of the society and prone to development of NCDs including T2D [26].

Cambodian health system is pluralistic, consisting of both public and private providers (including non-for-profit organisations). The public healthcare system has three tiers of administration: (1) district level, (2) provincial level, and (3) national or central level. The PHC approach has been adopted to reflect the Alma-Ata Declaration [17]. Based on implementation of the health coverage plan in 1995, one operational health district (OD) covers a catchment area of population from 100,000 to 200,000 in which one referral hospital provides secondary care and approximately 10-25 health centers provide primary care [27]. Each health center delivers health services to communities with support of community health workers based on national operational and clinical guidelines on a minimum package of activities (MPA) for health centers [28, 29], and the referral hospital operates health services following a national guideline on complementary package of activities to that of the health center. Severe cases can be referred for a tertiary care at a national hospital [30]. Despite the different levels of care, there is no strict practice of using the primary care provider as a gatekeeper. According to a recent update in 2022; across the 25 provinces and capital in the country, there were 103 ODs, 120 referral hospitals, and 1,269 health centers [31]. Main health care activities at health centers are still prevention and treatment of communicable diseases (such as HIV and AIDS, tuberculosis, and malaria) and maternal and child health [27]. Most health centers have limited capacity to prevent, diagnose and manage NCDs including T2D due to lack of equipment and materials, unavailability and inadequacy of essential medicines and supplies, and poor basic infrastructure [32]. This has given opportunities for private providers who are operating largely without sufficient steering and coordination from the government to play the main role in offering treatment and management of NCDs including T2D [33]. **Figure 1** shows the three tiers of public healthcare system and total numbers of public health facilities by the end of 2022.

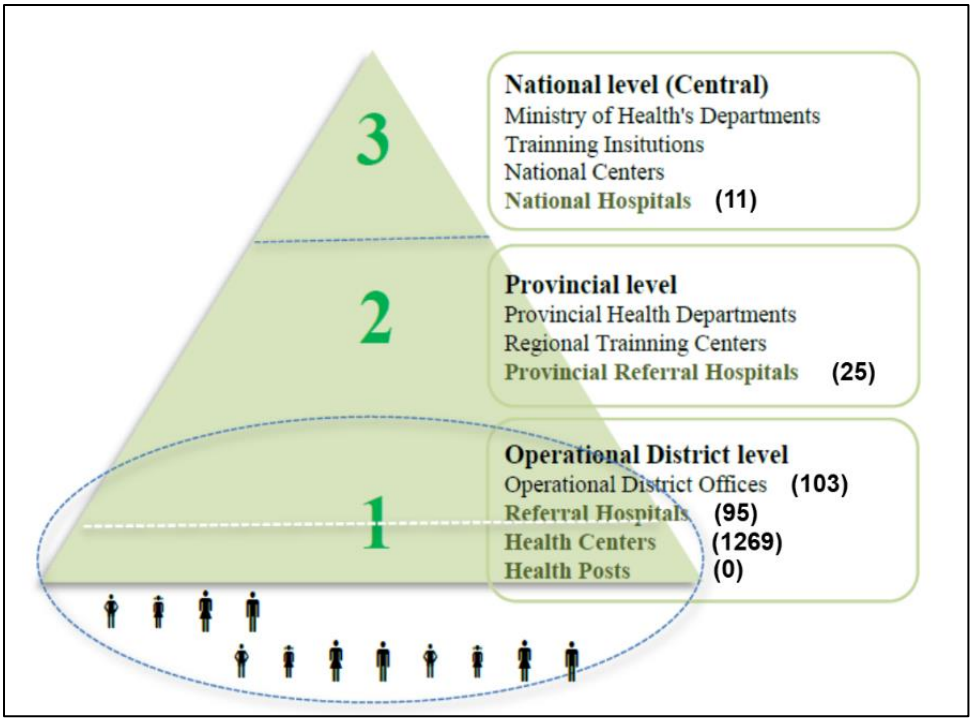

Figure 1. Administration tiers of public healthcare system and total numbers of public health facilities (Cambodia, 2022)

Cambodia has also been severely affected by the T2D epidemic. The prevalence of T2D, in 2016, was 9.6% among the adult population aged 18-69, while it was only 2.9% among the age group 25-64 in 2010 [34]. T2D care in Cambodia has been limited among the population at risk and people living with it. More than two-thirds of the adult population have never had their blood glucose tested and more than half of those living with T2D are not receiving treatment [34].

In response to the increasing burden of NCDs including T2D, the Royal Government of Cambodia through the Ministry of Health have developed important policy instruments to guide implementation of management of NCDs including T2D in the PHC [32, 35]. The Ministry of Health, based on the WHO PEN, specifically developed a national standard operating procedure for T2D and hypertension managment in primary care and approved it for use in 2019 [36]. In this standard operating procedure, three main diabetes care initiatives (DCIs) (hospital-based, health center-based, and community-based) complement each other for the continuity of care in which health centers provide coordination across the care levels in the OD. **Figure 2** shows an implementation arrangement of the three DCIs for the managment of T2D and hypertension in the PHC.

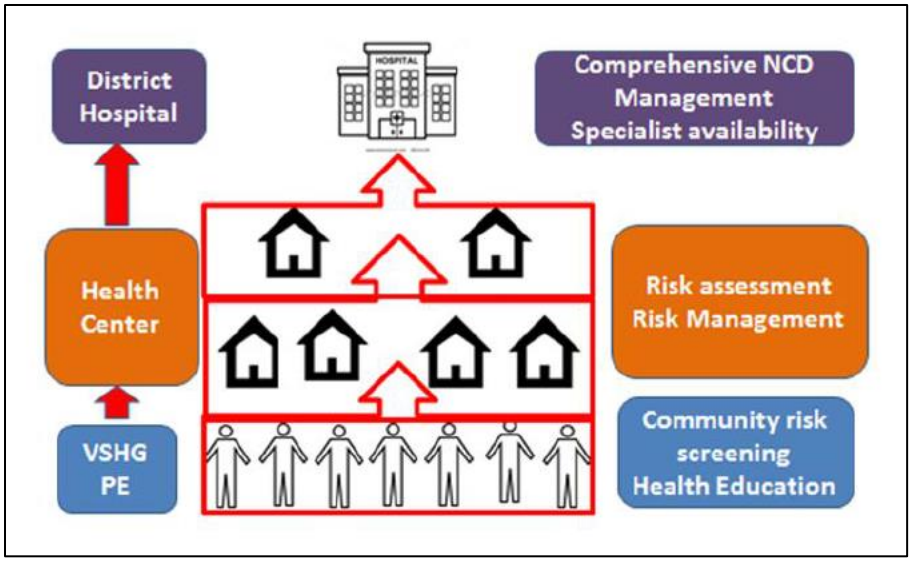

Figure 2. Impementation arrangement of the three DCIs for the managment of T2D and hypertension in the PHC [36]

- Community-based care is offered by community health workers – operating by either a village health support group formally recognised by the Ministry of Health or a peer educator network supported by a Cambodian non-governmental organisation called MoPoTsyo. The peer educator network exclusively provides services to people with T2D and/or hypertension. The peer educators – also people living with T2D – offer risk screening and health education to the community and self-management support to people with T2D in their network and assist the patients to have access to physician consultation, laboratory tests, and low-cost medicines through a revolving drug fund program at referral hospitals with which the organisation has partnership agreement [37]. The village health support group, on the other hand, perform multiple functions in the community including health awareness raising. They are usually members of commune councils. Their function in the managment of T2D and hypertension is limited. Therefore, the community-based care for T2D in this study only includes the one provided by the peer educator network of MoPoTsyo. In 2005, MoPoTsyo established this community-based care for T2D in a slum area in Phnom Penh, the capital. With progressive expansion in coverage, in 2022, the organisation had their networks in 21 ODs of eight provinces [38].

- Health center-based care for T2D is provided at health centers already equipped to implement the national standard operating procedure [36]—we call them the WHO PEN health centers. Up to date (in 2023), there were 252 health centers (out of 1,269) implementing the WHO PEN in the country [39]. They screen for T2D (targeting the population aged 40 and over), assess risk factors, provide follow-up care for mild and

stable T2D cases without complications, and offer counselling on positive lifestyle changes for risk management.

- Hospital-based care is provided at NCD clinics of referral hospitals focusing on confirmation of diagnosis, treatment initiation and treatment of serious or complicated T2D cases. In 2007, the Ministry of Health opened five clinics at five referral hospitals with support from the World Diabetes Foundation and the expansion in coverage has taken place until now – 67 clinics are operating the T2D services in 67 (out of 120) referral hospitals [39].

Based on the standard operating procedure which has to be aligned with the Cambodian public healthcare system, the three DCIs are required to be in the implementation structure; however, the prime focus is to strengthen the primary care level with more and more health centers having capacity to provide care for T2D and hypertension. To support the implementation of the standard operating procedure, a separate NCD clinic at the referral hospital and a community-supported network are required—they are also being scaled up by various funders or stakeholders.

ICCC Framework and the three DCIs

The national standard operating procedure for management of T2D and hypertension in primary care intends to integrate the three DCIs (hospital-based, health center-based, and community-based) for care continuum for T2D and hypertension in which health centers provide the continuity and coordination across the care levels in an OD [36]. This has been in line with the ICCC framework adopted by the WHO in 2002 which serves as a roadmap for health system transformation, given that chronic conditions are to be lived with for a prolonged period of time and mostly with multiple morbidities [4]. Adapted from the Chronic Care Model (CCM) [40] found to be effective for management of T2D in primary care in terms of improved clinical outcomes [41-48], the ICCC framework is more comprehensive and applicable to a wider international context including LMICs. The ICCC care components are grouped into three levels of building blocks namely, micro-level (a building block at the triad interaction between people with chronic conditions and their families, healthcare team, and community partners), meso-level (a building block for the healthcare organisation and for the community), and macro-level (a building block for the positive policy environment). **Figure 3** shows the three building blocks of the ICCC framework.

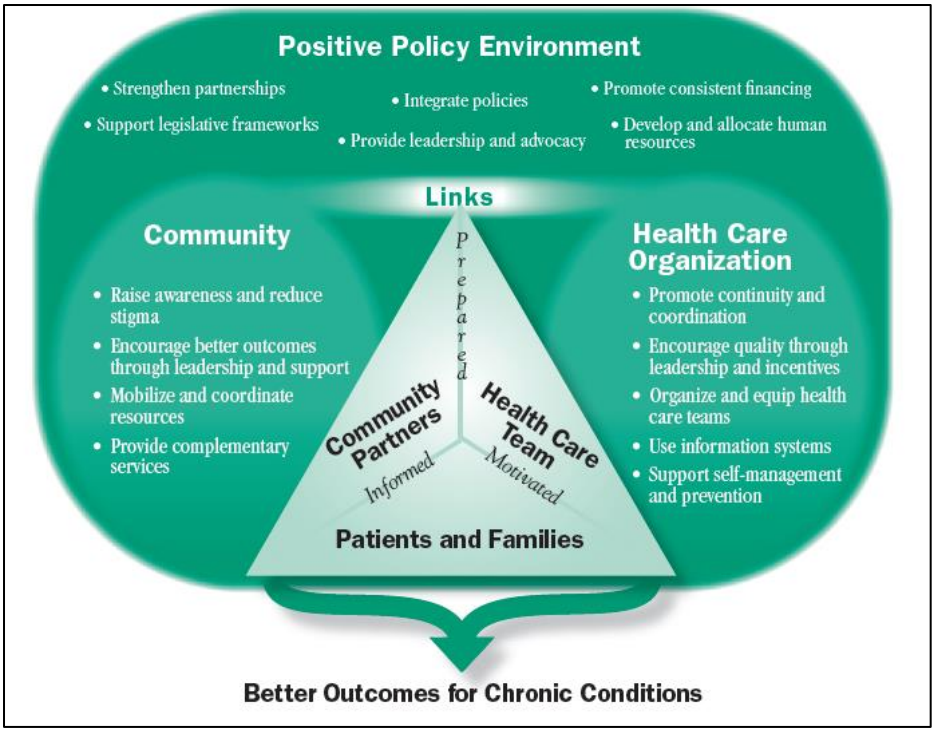

Figure 3. The ICCC building blocks

In 2012, Nuño and colleagues published a review on the contribution of the ICCC framework to the health system transformation toward better care for chronic conditions [7]. They saw that the ICCC framework fitted well in the context of LMICs on the health policy development where integration and coordination at the policy environment is of vital importance to link the patient and family, healthcare organisation, and community together to ensure the continuity of care. The community role in supporting care for chronic conditions is as equally important as the healthcare organisation role, and people with chronic conditions and their families as well as other community networks have gained more influence in decision making on their health conditions. Each level of the building blocks is guided by six principles: (1) evidence-based decision making; (2) population focus; (3) prevention focus; (4) quality focus; (5) flexibility and adaptability; and (6) integration, coordination, and continuity [4]. Each level interacts with and influences the other levels in a dynamic manner [4].

The triad at the core of the ICCC framework suggests that if healthcare organisation (hospital-based care and health center-based care) and community (community-based care) work together in terms of shared necessary information and coordinated resources, this would represent an ideal context for the integrated care continuum for T2D. Yet, there is no single study assessing the ICCC framework comprehensively in the health system setting [7]. Care components for T2D in relation to the ICCC building blocks effectively implemented in the health systems have not been systematically documented. The three DCIs (hospital-based, health center-based, and community-based) are being scaled up in the Cambodian public healthcare system, and their

implementation arrangement for the managment of T2D in the Cambodian PHC [36] would allow us to comprehensively assess the ICCC framework in the health system setting. However, up to date, there is no systematic study conducted to evaluate the extent the three DCIs have performed in providing T2D care to the population in Cambodia.

Goal and Objectives

The main goal of this PhD thesis is to systematically evaluate the performance of the three DCIs in Cambodia according to the national standard operating procedure for T2D and hypertension managment in primary care [36], which is a reflection of the ICCC framework. Performance in this study is defined as the capacity of the DCI implemented as part of the Cambodian health system for meeting needs of the population at risk and those with T2D from testing to controlling their blood glucose level.

Specific objectives are as follows:

1. To map effective care components for T2D implemented in the ASEAN health systems in relation to the ICCC framework;
2. To assess the performance of the three DCIs—either individually or in co-existence—in screening and diagnosing target population, linking them to care, retaining them in treatment, and controlling their blood glucose;
3. To assess healthcare usage of the three DCIs among people with T2D;
4. To assess implementation of the three DCIs—either individually or in co-existence.

Study Objective 1 gives an overview of T2D care components and their implementation in the health systems of ASEAN in which Cambodia is one of the member states. The ICCC framework is brought into focus in this objective. Study Objective 2 is the main objective closely linked to the main goal and guides selection of study settings; while Study Objective 3 and 4 help explain the observed performance of the DCIs.

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Chapter 2: Research Methodology

Study Design

To address the specific study objectives, a mixed-methods research with concurrent design was employed [1]. Qualitative data and quantitative data were collected and analysed to inform and build on each other during a similar timeframe. The study collected data from multiple sources of data and levels of the health system (population level, healthcare organisation level, and policy level) [2] between 2019-2020.

Study Settings

Through the stakeholder interviews with program managers of the three DCIs at the national level, we purposively selected ODs based on availability of the DCIs to ensure a maximal spread, which embodied the full spectrum of existing DCIs in Cambodia: (1) the co-existence of the three DCIs (hospital-based, health center-based, and community-based), (2) hospital-based care only, (3) health center-based care only, and (4) community-based care only. It is noted that based on the implementation arrangement, health centers can implement the WHO PEN only there is availability of the NCD clinic of referral hospital [3]. Therefore, the health center-based care which is provided by the WHO PEN health center is supported by the NCD clinic. We further selected ODs with low and high coverage of the WHO PEN health centers to see the influence level of the WHO PEN; as a result, five ODs in different provinces were selected in this study. These five ODs were thus the ideal clusters to evaluate the performance of different DCIs either individually or in co-existence (study objective 2) according to the ICCC framework. **Table 1** shows the five selected settings and availability of the DCIs in each setting. **Figure 4** shows locations of the study settings in Cambodia.

Table 1. Five ODs and the availability of the DCIs

OD	Province	Existing care provision	DCI(s)
1) Daunkeo	Takeo	NCD clinic + WHO PEN + Peer Educator Network	Co-existence of the three DCIs
2) Pearaing	Prey Veng	NCD clinic + WHO PEN (high coverage)	Health center-based care
3) Sotr Nikum	Siem Reap	NCD clinic + WHO PEN (low coverage)	Health center-based care with context
4) Kong Pisey	Kampong Speu	Peer Educator Network	Community-based care
5) Samrong	Oddar Meanchey	NCD clinic	Hospital-based care

- OD Daunkeo in Takeo province conducted the three DCIs together, which only co-existed in this OD. The hospital-based care was provided at a Chronic Disease Clinic [4] which provided treatment and care to both people with T2D and/or hypertension and those with HIV [4] – the clinic was essentially the NCD clinic of the referral hospital. The health center-based care was implemented in eight out of 15 health centers, and the community-based care was provided by the peer educator network of MoPoTsyo.

- OD Pearaing in Prey Veng province conducted the health center-based care where the WHO PEN was implemented in eight out of nine health centers (i.e. high coverage).

- OD Sotr Nikum in Siem Reap province conducted the health center-based care – with historical and significant influence from various development partners and non-governmental organisations (the contextual factor) – where the WHO PEN was implemented in five out of 25 health centers (i.e. low coverage). In this OD, the Chronic Disease Clinic was also operating in the Sotr Nikum referral hospital.

- OD Kong Pisey in Kampong Speu province conducted the community-based care organised by the peer educator network. The referral hospital in this OD did not formally offer care for T2D, but the peer educator network made the arrangement with the referral hospital to provide physician consultations for people with T2D in the network once a week.

- OD Samrong in Oddar Meanchey province conducted the hospital-based care in the NCD clinic of the referral hospital – the only public provider for T2D care in the OD.

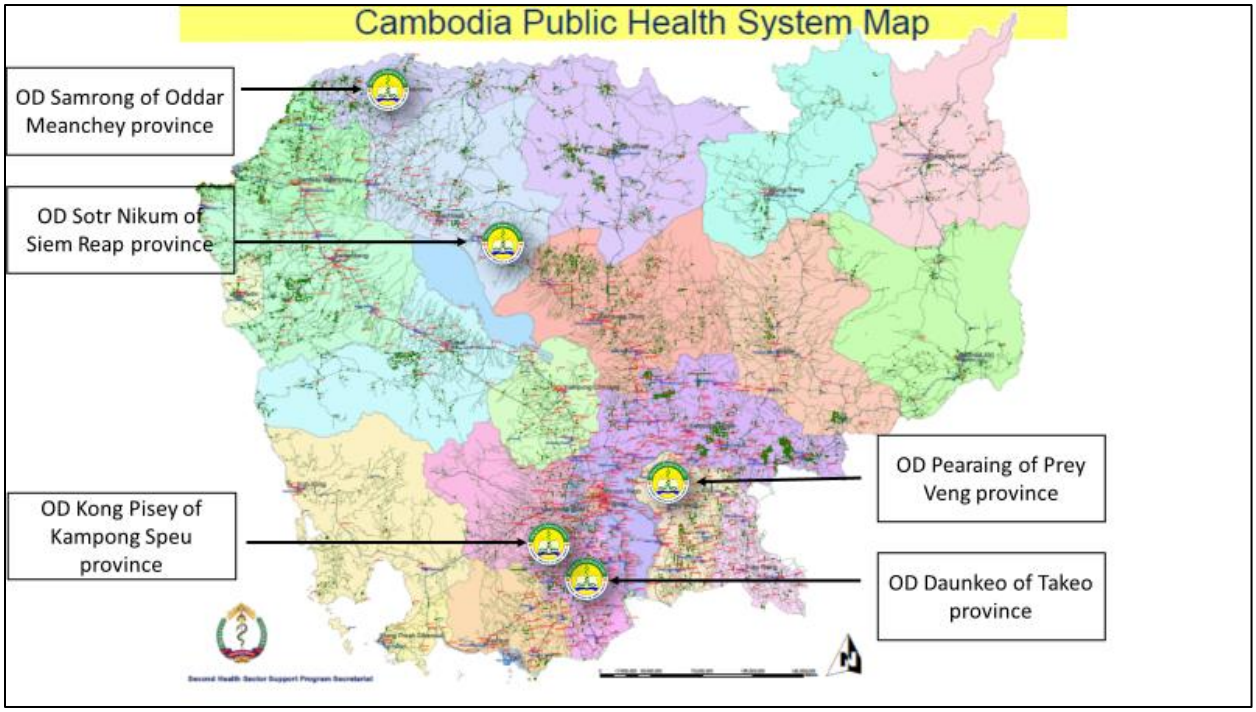

Figure 4. Locations of the five selected ODs in Cambodia

Research Methods

Various research methods both qualitatively and quantitatively were used to address all the study objectives. The qualitative part involved document review, stakeholder interviews, and an in-depth analysis of implementation; while the quantitative part involved a population-based survey and an analysis of secondary data. First, the qualitative data were collected through document review and stakeholder interviews to inform subsequent quantitative data collection of the population-based survey. Results of the stakeholder interviews were not presented as a standalone manuscript but discussed concerning T2D-related policy context in the Discussion section. Then the quantitative survey data were supported by qualitative data of in-depth analysis of T2D care implementation at healthcare facilities. These qualitative data were transformed into a quantifiable scoring system with qualitative justifications. A secondary data of T2D service availability in primary care facilities were also analysed to back the in-depth analysis of the implementation. **Table 2** shows research methods used for meeting each study objective and related subsequent chapters of findings.

Table 2. Research methods used for meeting the study objectives and the subsequent chapters of findings

Study Objective	Research Method	Data type	Chapter of findings
Objective 1	Document Review	Qualitative	Chapter 3: Diabetes care components effectively implemented in the ASEAN health systems: an umbrella review of systematic reviews (Published)
Objective 2	Population-based survey	Quantitative	Chapter 4: Generation of cascades of care for diabetes and hypertension care continuum in Cambodia: protocol for a population-based survey protocol (Published) Chapter 5: Evaluation of diabetes care performance in Cambodia through the cascade-of-care framework: cross-sectional study (Published)
Objective 3	Population-based survey	Quantitative	Chapter 6: Healthcare usage and expenditure among people with type 2 diabetes and/ or hypertension in Cambodia: results from a cross-sectional survey (Published)
Objective 4	Analysis of secondary data	Quantitative	Chapter 7: Availability of diabetes services in Cambodian primary care facilities: an analysis of self-reported survey with health center staff (Published)
	In-depth analysis of implementation	Qualitative transformed into quantitative	Chapter 8: An in-depth analysis of the degree of implementation of integrated care for diabetes in primary health care in Cambodia (In review)

Document review

A document review was conducted to map the effective care for T2D in the ASEAN in which Cambodia is a member state to meet Objective 1. The ASEAN was formed in 1967 at the juncture of the WHO Western Pacific and South East Asia regions consisting of 10 member states: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam [5]. This was an umbrella review of systematic reviews and/or meta-analyses conducted to identify the care components for T2D which have been implemented in the ASEAN health systems and shown effectiveness in terms of improved clinical outcomes,

psychosocial outcomes, or behavioural outcomes; following the Joanna Briggs Institute guidelines for conducting the umbrella review [6]. Four databases were searched: Health System Evidence, Health Evidence, PubMed, and Ovid MEDLINE. The reporting of study selection was done according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) [7]. The studies had to be a systematic review or meta-analysis or review of systematic reviews of experimental studies such as, randomised controlled trials, cluster-randomised controlled trials, etc. researching T2D or T2D-related conditions in English language. The studies had to focus on disease management as defined by the Care Continuum Alliance as "a system of coordinated healthcare interventions and communications for populations with conditions in which patient self-care efforts are significant" [8]. Therefore, any intervention or strategy related to plan of care; primary health care; support of physicians in care; patient empowerment/self-management; patient health education; enhancement of physician and patient relationship; evidence-based practice guidelines on prevention of conditions and complications; evaluation of clinical, economic and humanistic outcomes; professional health workforce; health information system; and health service delivery would be part of the disease management. This review allowed us to map the care components for T2D in relation to the ICCC building blocks. Two reviewers (myself and another researcher) independently extracted important data, evaluated the extracted data based on pre-determined themes of the ICCC constructs of care components, and narratively synthesised findings about the effective T2D care components block by block. Nevertheless, it only included studies which at least included one ASEAN member state in their study settings. This did not directly translate that the effectiveness was exclusively attributable to the ASEAN settings. It merely indicated that the ASEAN settings were taken into analyses of the included systematic reviews and/or meta-analyses. **Annex 1** gives details on the ICCC building blocks and their constructs of care components, and **Annex 2** shows key findings of the review.

Stakeholder interviews

16 stakeholder interviews with relevant agencies at the national level (four policy makers from the Ministry of Health, one policy maker from a governmental agency outside the Ministry of Health, seven representatives from development partners and non-governmental organisations, three representatives from a professional body in terms of clinical practices, and one representative from an academic institution) were conducted to gain in-depth understanding of the topic for the subsequent objectives (Objective 2, 3, & 4). At least two interviewers (under my leadership) conducted the interview with each stakeholder. We asked them based on guiding themes and codes, focused on (1) practice and implementation, (2) financing system, (3) related policies, (4) scale up process, and (5) recommended strategies for scale up (see **Figure 5**). The interviews were digitally recorded and taken notes by the interviewers. The recorded interviews were verbatim transcribed into the Cambodian language (Khmer). Transcribed data were thematically analysed and coded following the guiding themes and codes. Open coding method was also used for emergent themes and codes [9]. The identified themes and codes were consulted with all the promotors and discussed with other interviewers. We used NVivo 12 (Plus) to manage the qualitative data. The findings of this work allowed us to locate and map the

availability of the DCIs in each OD with indication of their functionality level based on perspectives of respective program managers. The findings of the interviews were thoroughly discussed in Chapter 9 of General Discussion—T2D-related policy context.

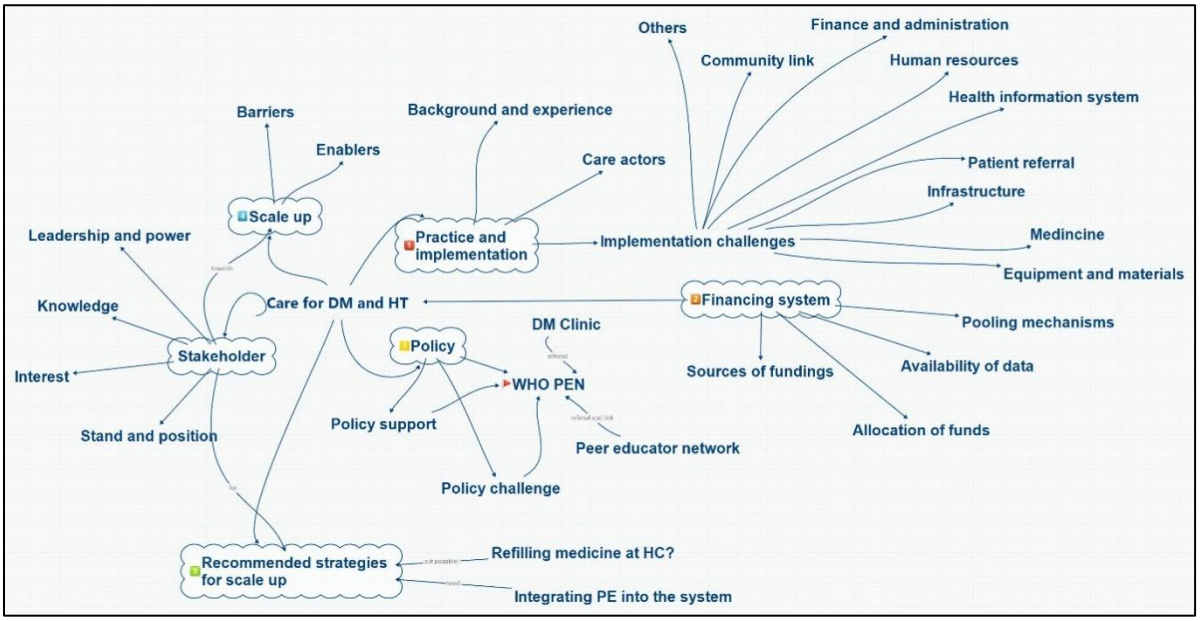

Figure 5. Framework of guiding themes and codes for the stakeholder interviews

Population-based survey

A population-based survey was conducted with 5,072 individuals aged 40 and over to meet Objective 2 and Objective 3. This population-based survey followed a multistage stratified random cluster sampling [10]. Three stages of stratification were applied, and in each stage randomisation was employed, with each OD as a stratum. For the first stage of stratification, sampling with equal probability was used to determine the number of villages (Primary Sampling Units) in each OD. For the second stage of stratification, households having adult(s) aged 40 and above (Secondary Sampling Units) in the selected villages were selected and listed. Systematic random sampling was used to select the households from each village. For the third stage of stratification, only one individual meeting eligibility criteria was randomly selected from each household to reduce the clustering effect. The eligible individuals were (1) those aged 40 and above, (2) being usual members of the household by having stayed in the household the night before the interview or not been absent for more than 6 months, (3) being physically and mentally capable to answer the questions, and (4) providing consent to participate in the study. The selected age group is the target population for screening for T2D, according to the national standard operating procedure [3].

The WHO STEPwise approach to NCD risk factor surveillance was employed with three main steps of data collection: (1) structured interviews with a questionnaire, (2) anthropometric

measurements, and (3) biochemical measurements [11]. The questionnaire used in the survey included sections on socio-demographic information, health status and co-morbidity, quality of life, healthcare utilisation, social support, behavioural measurements, knowledge of T2D and hypertension, medical adherence, and decision-making power over diet. **Annex 3** gives details of the questionnaire. The anthropometric measurements included measurements of blood pressure, body weight, height, and waist and hip circumferences. The biochemical measurements included testing of fasting blood glucose (FBG) for all the participants and glycated hemoglobin (HbA1c) and creatinine for known T2D patients or participants having FBG≥126 mg/dl. Data were digitally collected using KoBoToolbox system developed by the Harvard Humanitarian Initiative [12].

For Objective 2, a cascade of care framework adapted from the HIV program was employed to assess the T2D care continuum [13]. The cascade of care in this study contained six bars including: (1) the Prevalence bar, (2) the Ever tested or screened bar, (3) the Ever diagnosed bar, (4) the In care bar, (5) the In treatment bar, and (6) the Under control bar. A fixed denominator approach was employed for constructing the cascades of care in order to identify leakages between stages of the care continuum [14]. **Table 3** shows definitions of each bar and describes the sources of data extracted for the analysis.

Table 3. Definitions of the cascade bars for T2D

Bars of the cascade of care for T2D	Definitions	Questions extracted for analysis
(1) Prevalence of the target population living with T2D	-Participants having biochemical measurement of FBG (capillary plasma value) ≥126 mg/dl (7 mmol/L) AND HbA1c level ≥6.5 % [14-16]	-Measurement of FBG -Measurement of HbA1c
	OR Participants reporting use of drugs for T2D, irrespective of their biomarker values	-Have you ever been told by a doctor or other healthcare worker that you have the T2D?
(2) Number of the target population with T2D ever tested for T2D	-Classified T2D patients having had FBG tested in the last 3 years	-Have you ever had your blood glucose tested in the last three years?
(3) Number of the tested ever diagnosed for T2D	-Tested T2D patients reporting ever being told by a doctor or other healthcare worker as having T2D	-Have you ever been told by a doctor or other healthcare worker that you have T2D?
(4) Number of the diagnosed in care	-Diagnosed T2D patients reporting getting treatment/care for their conditions at least once in the past 12 months	-Did you get treatment/care for your T2D condition in the past 12 months?

(5) Number of those in care receiving treatment	-T2D patients in care reporting using drugs for T2D or insulin in the past two weeks OR	-Are you currently receiving any of the following treatment for your T2D condition prescribed by a doctor or other healthcare worker? • Insulin OR • Drugs (medication) that you have taken in the past two weeks
	-T2D patients in care reporting following advice to lose weight, stop smoking, do physical exercise, and be on special prescribed diet	-Are you currently receiving any of the following advices for your T2D condition prescribed by a doctor or other healthcare worker? • Special prescribed diet AND • Advice to lose weight AND • Advice to stop smoking AND • Advice to start or do more physical exercise
(6) Number of those receiving treatment being under control	-T2D patients in treatment having HbA1c level < 8 % [14]	- Measurement of HbA1c for the known T2D

We also determined factors associated with the undiagnosed status of participants living with T2D. We defined the "undiagnosed status" as a person having the biochemical measurement of FBG ≥126 mg/dl AND HbA1c level ≥6.5 % but never being told by a doctor or other healthcare worker that he/she had T2D. The explanatory variables for the analysis included demographic characteristics, socio-economic status, and the different DCIs (either individually or in co-existence).

For Objective 3, we used a subset of the survey sample. We only retained those who reported using healthcare services at least once in the three months preceding the survey. A total of 2,360 (out of 5,072 participants) met this criterion. The 2,360-participant-sample-subset included four patient groups: 1,331 people without T2D and hypertension, 109 people with T2D alone, 761 people with hypertension alone, and 159 people with T2D plus hypertension. The primary variable of interest was the number of visits to public and private facilities. Public healthcare facilities were referred to government-run facilities providing medical services including: national

hospitals, referral hospitals, and health centers. Private healthcare services were medical and non-medical services operated by non-government organisations including private hospitals, private clinics, pharmacies, homes of trained health workers, and visits of healthcare workers to the patients' homes. Traditional healing/medicine and using healthcare services abroad were also part of this category. The secondary variable of interest was healthcare expenditure, the lump sum expenditure of medical consultations, treatment, and medication. The participants were asked about their use of health services in the three months preceding the survey (where they went, how often they went to a particular type of healthcare facility, and how much they spent in each facility in those three months). The expenditure did not include other expenses such as on transport, food, or accommodations.

Analysis of secondary data

An analysis of secondary data was carried out to assess availability of T2D services at primary care facilities (health centers) in Cambodia to meet Objective 4. The analysis was based on an existing dataset of self-reported survey with health center staff conducted by the National Institute of Public Health in 2020. This secondary data represented 95% of the total health centers in Cambodia at the time of data collection. Data related to the availability of T2D services and the associated characteristics of service inputs were extracted for a descriptive analysis.

In-depth analysis of implementation

An in-depth analysis of T2D care implementation was carried out in each of the study settings to meet Objective 4 in a deeper level. In each OD, we assessed the referral hospital and three randomly selected health centers –in total, five referral hospitals and 15 health centers were assessed. The ICP grid which stands for Integrated Care Package Implementation Assessment Framework was used as an instrument to assess the integrated care for T2D. It was developed based on two assessment tools which have been validated and widely used in high- and low-income settings to assess integrated care for chronic conditions: (1) the Assessment of Chronic Illness Care Form [17] and the ICCC Framework Situation Assessment Form [18]. The tool development was done in a joint effort of the SCUBY (Scale up diabetes and hypertension care for vulnerable people in Cambodia, Slovenia and Belgium) project [19] in which all the promotors and myself were involved. The ICP grid allowed us to measure six components of the integrated care including: (1) early detection and diagnosis, (2) treatment in primary care services, (3) health education, (4) self-management support, (5) structured collaboration, and (6) organisation of care. Questions of each component was rated on a 0-5 scale: 0= 'no implementation', 1= 'little implementation', 2= 'lower moderate implementation', 3= 'upper moderate implementation', 4= 'almost complete implementation', and 5= 'full implementation'. The ICP grid is a synthesis of multiple sources of data collection which involved, in each OD, key informant interviews with management team of provincial health department, OD, and referral hospital; focus group discussions with healthcare workers, community health workers, and patients; site observation; and patient record check. The key informant interviews and focus group discussions were digitally recorded and verbatim transcribed into Khmer. During the site

visits, implementation procedures and relevant records were photographed. These qualitative data were used to support the quantifiable scoring system as described above but were not fully analysed in their own right. The two raters (myself and another researcher) who conducted the data collection in all the study settings independently analysed the collected data based on the pre-determined themes and codes (components and sub-components of the integrated care) in the ICP grid and scored each health facility. Each rater needed to provide a written justification for each score given. Then the two raters reached a consensus final score facility by facility through discussion with verification of the data collected (recordings, transcriptions or memos, and photos). Every decision during the discussions between the raters was properly documented in NVivo 12 (Plus). Details of the ICP grid are given in **Annex 4**.

Ethical Approval

The studies were approved by the National Ethics Committee for Health Research in Cambodia with reference number 105 NECHR and by the Institutional Review Board of Institute of Tropical Medicine (Antwerp) with reference number 1323/19.

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Part 2: Findings

- **Chapter 3**: Diabetes care components effectively implemented in the ASEAN health systems: an umbrella review of systematic reviews
- **Chapter 4**: Generation of cascades of care for diabetes and hypertension care continuum in Cambodia: protocol for a population-based survey protocol
- **Chapter 5**: Evaluation of diabetes care performance in Cambodia through the cascade-of-care framework: cross-sectional study
- **Chapter 6**: Healthcare usage and expenditure among people with type 2 diabetes and/ or hypertension in Cambodia: results from a cross-sectional survey
- **Chapter 7**: Availability of diabetes services in Cambodian primary care facilities: an analysis of self-reported survey with health center staff
- **Chapter 8**: An in-depth analysis of the degree of implementation of integrated care for diabetes in primary health care in Cambodia

Part 2: Findings

Chapter 3: Diabetes care components effectively implemented in the ASEAN health systems: an umbrella review of systematic reviews

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Abstract

Objectives: Association of Southeast Asian Nations (ASEAN) is among the hardest hit low-income and middle-income countries by diabetes. Innovative Care for Chronic Conditions (ICCC) framework has been adopted by the WHO for health system transformation towards better care for chronic conditions including diabetes. We conducted an umbrella review of systematic reviews on diabetes care components effectively implemented in the ASEAN health systems and map those effective care components into the ICCC framework.

Design: An umbrella review of systematic reviews and/or meta-analyses following the Joanna Briggs Institute (JBI) guidelines.

Data sources: Health System Evidence, Health Evidence, PubMed and Ovid MEDLINE.

Eligibility criteria: We included systematic reviews and/or meta-analyses which focused on management of type 2 diabetes, reported improvements in measured outcomes and had at least one ASEAN member state in the study setting.

Data extraction and synthesis: Two reviewers independently extracted the data and mapped the included studies into the ICCC framework. A narrative synthesis method was used to summarise the findings. The included studies were assessed for methodological quality based on the JBI critical appraisal checklist for systematic reviews and research syntheses.

Results: 479 records were found of which 36 studies were included for the analysis. A multidisciplinary healthcare team including pharmacists and nurses has been reported to effectively support patients in self-management of their conditions. This can be supported by effective use of digital health interventions. Community health workers either peers or lay people with necessary software (knowledge and skills) and hardware (medical equipment and supplies) can provide complementary care to that of the healthcare staff.

Conclusions: To meet challenges of the increased burden of chronic conditions including diabetes, health policy-makers in the ASEAN member states can consider a paradigm shift in human resources for health towards the multidisciplinary, inclusive, collaborative and complementary team.

Strengths and limitations of this study

- This study could be the first attempt to map the effective care components for diabetes implemented in the Association of Southeast Asian Nations (ASEAN) health systems into the Innovative Care for Chronic Conditions building blocks.
- The findings of this umbrella review were syntheses of systematic reviews and/or meta-analyses, which were critically appraised for methodological quality.
- The search in only four databases might potentially miss out other publications discussing effective care components for diabetes in other sources of data.
- The study gave a narrative overview of the systematic reviews and/or meta-analyses that at least included one ASEAN member state in their study settings, but this did not directly translate that the effectiveness was exclusively attributable to the ASEAN settings. It merely means that the ASEAN settings were taken into analyses of the included systematic reviews and/or meta-analyses.

Introduction

Diabetes is one of the chronic conditions directly contributing to the death of an estimated 1.5 million people worldwide in 2019 (ranked ninth of the world leading causes of death).[1] In 2021, globally 1 in 10 adults aged 20-79 were living with diabetes.[2] The WHO Western Pacific (206 million) and South East Asia regions (90 million) were ranked first and second for having the most adults living with diabetes, respectively.[2]

Diabetes is one of the major risk factors for cardiovascular diseases and other non-communicable diseases, and between 2000 and 2016, there was an increase of premature mortality (deaths before the age of 70) from diabetes by 5% in both high-income countries (HICs) and low-income and middle-income countries (LMICs).[1] To cope with the increased prevalence of diabetes, more robust and proactive healthcare systems are needed.[3] Nevertheless, many health systems are still reactive, episodic, fragmented and physician-centred, rendering them less well equipped to continuously manage chronic conditions.[4] Consequently, needs of people living with diabetes are likely to go unmet, and coping with the chronic complications is often an individual struggle.

Association of Southeast Asian Nations (ASEAN) formed in 1967 at the juncture of the above-mentioned WHO regions are among the LMICs hardest hit by diabetes. The ASEAN consists of 10 member states: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.[5] Health systems of these member states are struggling at various stages to deal with increased chronic conditions among their populations.[6] By income level classified by the World Bank in 2020, all the member states were classified as LMICs except Brunei Darussalam and Singapore already classified as HICs.[7]

In 2002, the WHO proposed an Innovative Care for Chronic Conditions (ICCC) framework to serve as a roadmap for health system transformation, given that chronic conditions are to be lived with for a prolonged period of time and mostly with multiple morbidities.[3] Adapted from the Chronic Care Model (CCM) that has been found to be effective for management of diabetes in primary care in terms of improved clinical outcomes,[8–16] the ICCC framework is more comprehensive and applicable to a wider international context including LMICs. The ICCC care components are grouped into three levels of building blocks namely, microlevel (a building block at the triad interaction between people with chronic conditions and their families, healthcare team and community partners), mesolevel (a building block for the healthcare organisation and for the community) and macrolevel (a building block for the positive policy environment). Each level of the building blocks is guided by six principles: (1) evidence-based decision-making, (2) population focus, (3) prevention focus, (4) quality focus, (5) flexibility and adaptability and (6) integration, coordination and continuity.[3] Each level interacts with and influences the other levels in a dynamic manner. Further details of the building blocks can be found in the WHO publication on the ICCC framework.[3]

In 2012, Nuño *et al* published a review on the contribution of the ICCC framework to the health system transformation towards better care for chronic conditions.[4] They saw that the ICCC

framework fitted well in the context of LMICs on the health policy development where integration and coordination at the policy environment is of vital importance to link the patient and family, healthcare organisation, and community together to ensure the continuity of care. The community role in supporting care for chronic conditions is as equally important as the one of healthcare organisation. People with chronic conditions and their families as well as other community networks have gained more influence in decision-making on their health conditions through the framework. The review found that the ICCC framework had been used as a reference for policy development and evaluation on healthcare reorientation towards chronic care in various countries including: the Russian Federation, Spain, England, Morocco, Rwanda and Australia.[4] Yet, no single study was identified in the literature to assess the framework comprehensively across the health system.[4] Its implementation in the ASEAN health systems also has not been widely documented. Two questions arise: (1) What are the care components for diabetes effectively implemented in the ASEAN health systems? and (2) How are they placed in the ICCC framework? In this study, we aim to conduct an umbrella review of systematic reviews to identify the care components for diabetes which were effectively implemented in the ASEAN health systems and map those care components into the ICCC building blocks.

Methods

Study design

An umbrella review of systematic reviews and/or meta-analyses was conducted to identify the care components for diabetes effectively implemented in the ASEAN health systems, following JBI guidelines for conducting the umbrella review.[17]

Search strategy and study selection

Four databases were searched: Health System Evidence, Health Evidence, PubMed and Ovid MEDLINE for relevant systematic reviews and/or meta-analyses published between 2009 and 2021. The search strategy was based on concepts of “type 2 diabetes”, “disease management in healthcare systems” and “ASEAN region”. Boolean operator “AND” was employed to combine the concepts, while Boolean operator “OR” was used to combine index terms and keywords of an individual concept. Detailed strategy for locating relevant studies in each database can be found in online supplemental table 1.

The reporting of study selection was done according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[18] The search results were collected in ENDNOTE software, a reference manager. We also used the software to remove duplicates. Then, studies for the review were selected based on a set of eligibility criteria (table 1). The studies had to be a systematic review or meta-analysis or review of systematic reviews of experimental studies such as, randomised controlled trials, cluster-randomised controlled trials, etc researching type 2 diabetes or type 2 diabetes-related conditions in English language. The studies had to focus on disease management as defined by the Care Continuum Alliance as ‘a system of coordinated healthcare interventions and communications for populations with conditions in which patient self-care efforts are significant’.[19] Therefore, any intervention or strategy related to plan of care;

primary healthcare; support of physicians in care; patient empowerment/self-management; patient health education; enhancement of physician and patient relationship; evidence-based practice guidelines on prevention of conditions and complications; evaluation of clinical, economic and humanistic outcomes; professional health workforce; health information system and health service delivery would be part of the disease management.

Table 1: Eligibility criteria and their descriptions

Eligibility Criterion	Description
Disease/Condition	Type 2 diabetes **or** type 2 diabetes-related conditions
Study type	Systematic review **or** meta-analysis **or** review of systematic reviews of experimental studies (with at least two reviewers)
Language	English
Study setting	At least having one ASEAN member state
Area in focus	Disease management
ASEAN, Association of Southeast Asian Nations.	

Studies had to meet all the eligibility criteria. The eligible studies were assessed of care effectiveness aspects as part of the disease management. Only the studies reporting improvements in any of the following measured outcomes were included for the full-text review.

The measured outcomes included: clinical outcomes (eg, glycated haemoglobin, blood glucose, blood pressures, body mass index, waste circumference, lipid profile, readmission, length of hospital stay, adverse events with complications, emergency department presentation and mortality), psychosocial outcomes (eg, self-efficacy, self-care competencies, health-related quality of life, knowledge and attitudes) and behavioural outcomes (eg, lifestyle modification, physical activity, diet, medication adherence, treatment concordance and attendance to clinical appointments).

Titles and abstracts of the studies found in the databases were screened by VT and SM based on the above-mentioned eligibility criteria to exclude irrelevant studies. Then, the remaining studies were assessed to identify the effectiveness of the interventions or strategies and classify them based on the ICCC framework. The classification was based on constructs of each care component detailed in online supplemental table 2. Study objectives, interventions or strategies under study and study conclusions were independently reviewed by VT and SM, and a consensus had to be

reached between the two reviewers. The included studies were required to have relevancy to at least one of the constructs of each care component.

Data extraction and synthesis

Two reviewers (VT and SM) extracted the data important to the research objectives and tabulated them in Microsoft Excel (online supplemental table 3). Those variables were: authors and year of publication, study objective, number of included studies, study design, study setting, intervention or strategy, measured outcome and study conclusion. We independently evaluated the extracted data thoroughly and categorised each study into the ICCC building blocks, using the constructs of care components as an analytical framework. A narrative synthesis method was used to summarise findings of the included studies which were also assessed for methodological quality, following the JBI critical appraisal checklist for systematic reviews and research syntheses.[17] In the checklist, there were 11 items with 4 response categories: 'yes', 'no', 'unclear' and 'not applicable or N/A'.

Patient and public involvement

There was no involvement of patients and members of the public in the design, conduct, reporting or dissemination of this study.

Results

Study retrieval

Based on the search strategy, 479 records were found (figure 1). Twenty duplicates were identified, and 416 did not meet all the eligibility criteria. Forty-three studies were eligible of which seven did not report improvements in any of the measured outcomes (online supplemental table 4). Therefore, 36 studies were finally included for the analysis.

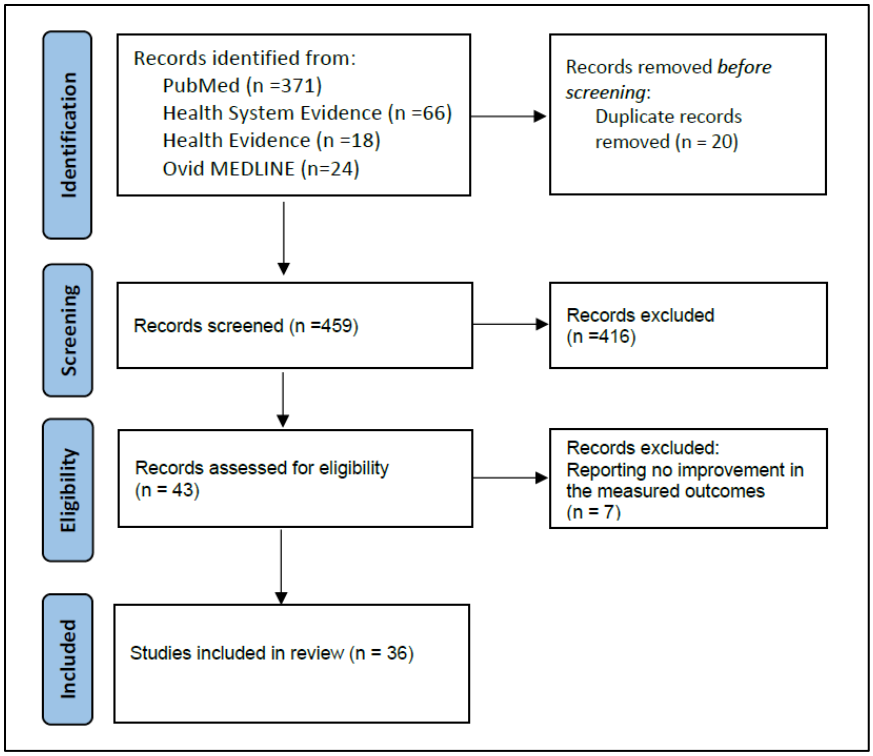

Figure 1. PRISMA flow diagram of the study selection. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Characteristics of included studies

Among the 36 included studies, by study type, 16 conducted systematic reviews; 3 conducted meta-analyses; and 17 conducted both systematic reviews and meta-analyses. The total number of studies included in the systematic reviews and/or meta-analyses was 1082 in which the study design in majority was randomised-controlled trial. Key findings of the included studies are summarised in online supplemental table 5. Detailed results of the methodological quality assessment can be found in online supplemental table 6. It was noted that more than half of the included studies did not assess the publication bias (21 out of 36). Among the ASEAN member states, only six namely: Thailand, the Philippines, Malaysia, Singapore, Cambodia and Vietnam appeared in the study settings of the included studies. Thailand appeared in 18 out of the 36 studies (table 2).

Table 2: Distribution of the ASEAN member states appearing in the study settings

ASEAN member states	Number of studies
Thailand	18 studies [20 28-34 36 37 39 47 48 51 55-58]
The Philippines	9 studies [20 21 24 40 41 43 44 48 55]
Malaysia	12 studies [21 23 25 26 28 31 32 38 45 48 49 58]
Singapore	7 studies [22 27 28 38 49 56 59]
Cambodia	4 studies [21 35 46 55]
Vietnam	5 studies [23 40-42 51]

ASEAN, Association of Southeast Asian Nations.

The ICCC building blocks

Microlevel

The microlevel—the building block at the triad interaction between people with chronic conditions and their families, healthcare team and community partners—was given attention in most of the reviewed studies (28 out of 36 studies). Most of the studies focused on self-management interventions supporting people with diabetes to improve their clinical outcomes, psychosocial outcomes or behavioural outcomes. Self-management strategies for people with diabetes had been proven to have positive effect on glycaemic control, especially with those having poorer glycaemic control. The most frequently used self-management strategies were psychological strategies, lifestyle advice and support, and information sharing about the condition and its management.

Mesolevel for the healthcare organisation

The mesolevel for the healthcare organisation was found in 24 studies in which 22 studies addressed the microlevel and mesolevel for the healthcare organisation together. The self-management interventions supported by the healthcare organisation could be carried out remotely in a form of telemedicine via smartphone functions to provide self-care education, facilitate self-monitoring, serve as a reminder and collect feedback for healthcare professionals to make treatment recommendations.[20 21] It was found to be more cost-effective, especially for teleophthalmology (retinal screening).[22] Teleconsultation, which refers to communication between healthcare providers and patients or between clinicians via email, automated messaging system, mobile phone or other forms of internet-based communication for provision of care from distance, was the most effective strategy.[23] Some focused on automated brief messaging or mobile phone text messaging with a preplanned algorithm.[24–27] A considerable number of studies identified the effectiveness of face-to-face interventions supported by healthcare professionals, in particular, pharmacists.[28–35] Those studies indicated that pharmacists

could effectively provide self-management activities to people with diabetes, when equipped with appropriate knowledge and skills[36] and integrated in a healthcare team.[28 29 33 37 38] A specialist care setting at the hospital was found to be effective in facilitating the coordinating role with primary care to promote the continuity of care.[39] There was one study revealing that pharmacists and nurses could substitute for physicians in prescribing medications for the patients with comparable clinical outcomes, medication adherence, health-related quality of life and patient satisfaction.[34]

Meso-level for the community

The mesolevel for the community was found in 7 studies. The self-management activities could effectively be supported by the community groups—either peers sharing similar experience, knowledge and characteristics to the patients[40–42] or lay people fulfilling the role as community health workers in a form of task shifting. [43–46] These community people needed to be prepared, informed and motivated to provide care complementary to that of the healthcare workers.

Macrolevel for the policy environment

There were limited studies focusing on the care components at the policy environment—only four studies. One study concluded that targeted screening, which only includes specific groups of population who have one or more risk factors for type 2 diabetes, was more cost-effective in comparison to universal screening, particularly initiated with people aged around 45–50 with every 5-year repetition.[47] Integrating diabetes care with HIV services was seen as feasible, with the pharmacist aide.[35] For the integration to be successful, a multidisciplinary team should be adopted with clear protocols, and the community should be used as locus for advocacy and health services.[35] A study examining health system-level factors showed that effective care for diabetes was hampered by limited access to health services and medications and financial constraints encountered by patients. It was enabled by increased involvement of pharmacists, educational programmes led by healthcare professionals and support of innovative care models.[48] In terms of cost-effectiveness, combining programmes such as diet and physical activity promotion programmes was proven cost-effective and economically efficient, especially with the use of group sessions.[49] Figure 2 shows the mapping of those studies in relation to the care components of the ICCC framework.

<table>
<tr><td colspan="2">Macro-level (4 studies)

• Integrate policies [47 35]
• Provide leadership and advocacy [48]
• Promote consistent financing [48 49]</td></tr>
<tr><td>Meso-level—Community (7 studies)

• Provide complementary services [40-42 44-46 55]</td><td>Meso-level—Health Care Organisation (24 studies)

• Use information systems [20-25 27 51]
• Support self-management and prevention [21 28-33 36-39 51 55 58 59]
• Organise and equip health care teams [28-33 36-39]
• Promote continuity and coordination [39 56]</td></tr>
<tr><td colspan="2">Micro-level (28 studies)

• Prepared, informed, and motivated patients and families [20-24 27-33 37-42 44-46 50-59]
• Prepared, informed, and motivated health care teams [28 29 39]
• Prepared, informed, and motivated community partners [40-43]</td></tr>
</table>

Figure 2. Mapping of the included studies in relation to the care components of the ICCC framework. ICCC, Innovative Care for Chronic Conditions.

Discussion

This overview of systematic reviews and/or meta-analyses found that most of the care components for diabetes effectively implemented in the ASEAN health systems were centred around the patients' self-management due to the fact that care for diabetes like other chronic conditions is reliant mainly on individual patients and not totally on medical treatment. In fact, patients could know and manage their conditions better, with correct and appropriate guidance, as they have lived with the conditions for ages.[50] Thus, self-management strategies have been prioritised to support people with the condition to increase their self-confidence in taking an active role in managing their conditions in all aspects.[51] This overview showed that the self-management strategies with effective outcomes were more frequently supported by the healthcare organisation, although community support was also effective, indicating that more interventions were targeting the healthcare organisation. The community role in supporting care for diabetes is complementary to that of healthcare organisation in the context of limited healthcare staff.[43] Either lay people or peers (expert patients) could provide added value to diabetes intervention programmes in terms of shared culture and language that is beneficial to a close rapport with the patients, resulting in greater mutual understanding and increased emotional assistance.[40 52] People with the condition, their families or caregivers and other

community networks can also gain more influence in decision making on the health conditions through the self-management strategies.

There has been increasing evidence of the effective role of pharmacists in the multidisciplinary healthcare team in supporting patients' self-management, aided by effective use of digital health. For sustainable benefits of the self-management strategies, multicomponent of diabetes care components was recommended.[53] This is consistent with other reviews which showed that combined care components had greater positive impact on the patients in terms of both processes and outcomes.[4] A meta-regression analysis on quality improvement strategies for type 2 diabetes care showed significant effects of two strategies (team changes and case management) on blood glucose control.[54] Team changes in that study were referred briefly to changes (eg, adding a team member, sharing care, employing a multidisciplinary team, expanding or revising professional roles) to the organisation of the primary healthcare team, which was similar to delivery system design component of the CCM.[4 54] Likewise, the case management was defined as a system for coordinating the care processes from diagnosis, treatment and management of the condition under control (eg, referral arrangement, follow-up care) by a specific person or the multidisciplinary team.[54] A systematic review also found that healthcare costs and utilisations related to usage of the multidisciplinary collaborative care model did not incur excessive costs either.[38]

It was noted that effective care components at the macrolevel were limitedly identified, indicating that the ICCC framework still has limited influence in the health systems transformation towards better care for chronic conditions despite two decades after its inauguration. Most of the studies identified and included in this review concentrated on the CCM care components (patient and healthcare organisation levels). It could be that the CCM care components have been feasibly and frequently evaluated through experimental studies and directly linked to the patients, caregivers and healthcare professionals at the microlevels and mesolevels. Nevertheless, the ICCC framework was found to be a useful reference for policy development and evaluation on healthcare reorientation towards chronic care in various countries as described above.[4]

This study could be the first attempt to map the effective care components for diabetes implemented in the ASEAN health systems into the ICCC building blocks. The findings of this umbrella review were syntheses of systematic reviews and/or meta-analyses which were critically appraised for methodological quality. This study, nevertheless, had limitations. The search in only four databases and from 2009 to 2021 might potentially exclude other publications discussing effective care components for diabetes in other sources of data or outside the publication year limit. This study gave a narrative overview of the systematic reviews and/or meta-analyses that at least included one ASEAN member state in their study settings, but this did not directly translate that the effectiveness was exclusively attributable to the ASEAN settings. It merely means that the ASEAN settings were taken into analyses of the included systematic reviews and/or meta-analyses. Future review should include more sources of data including grey literature and measure effect of studies in the ASEAN settings.

Conclusions

This umbrella review identified effective care components for diabetes implemented in the ASEAN health systems. From the findings, it is recommended that the multicomponent care be adopted. The multidisciplinary healthcare team including pharmacists and nurses could effectively support patients in self-management of their conditions and improve clinical, psychosocial and behavioural outcomes. With clear guidelines and supported supervision, there is a possibility that pharmacists and nurses be given the prescribing autonomy within the agreed level. Effective use of digital health interventions can be beneficial to the self-management support. Where there are staffing shortages in healthcare organisation, community health workers either peers or lay people could be equipped with necessary software (knowledge and skills) and hardware (medical equipment and supplies) to provide the complementary care. The findings are insightful for health policy makers in the ASEAN member states to consider a paradigm shift in utilisation of human resources for health to support implementation of the ICCC framework to meet challenges of the increased burden of chronic conditions including diabetes. It is the shift towards the multidisciplinary, inclusive, collaborative and complementary team.

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Contributors
VT and SM conducted the searches, screened and reviewed the identified studies, and did the analysis on the included studies. JvO and EW offered advice on the ICCC conceptual framework and prepared the first draft with VT. IP and WVD provided feedback on the methodology and consultation on the review of the included studies. All the authors provided feedback on the drafts and approved the final manuscript.

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All data relevant to the study are included in the article or uploaded as online supplemental information.

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Chapter 4: Generation of Cascades of Care for Diabetes and Hypertension Care Continuum in Cambodia: Protocol for a Population-Based Survey Protocol

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Abstract

Background: Cardiovascular diseases (CVDs) were accountable for 24% of the total deaths in Cambodia, one of the low- and middle-income countries, where primary health care (PHC) settings generally do not perform well in the early detection, diagnosis, and monitoring of leading risk factors for CVDs, that is, type 2 diabetes (T2D) and hypertension (HT). Integrated care for T2D and HT in the Cambodian PHC system remains limited, with more than two-thirds of the population never having had their blood glucose measured and more than half of the population with T2D having not received treatment, with only few of them achieving recommended treatment targets. With regard to care for T2D and HT in the public health care system, 3 care models are being scaled up, including (1) a hospital-based model, (2) a health center–based model, and (3) a community-based model. These 3 care models are implemented in isolation with relatively little interaction between each other. The question arises as to what extent the 3 care models have performed in providing care to patients with T2D or HT or both in Cambodia.

Objective: This protocol aims to show how to use primary data from a population-based survey to generate data for the cascades of care to assess the continuum of care for T2D and HT across different care models.

Methods: We adapt the HIV test-treat-retain cascade of care to assess the continuum of care for patients living with T2D and HT. The cascade-of-care approach outlines the sequential steps in long-term care: testing, diagnosis, linkage with care, retention in care, adherence to treatment, and reaching treatment targets. Five operational districts (ODs) in different provinces will be purposefully selected out of 103 ODs across the country. The population-based survey will follow a multistage stratified random cluster sampling, with expected recruitment of 5280 eligible individuals aged 40 and over as the total sample size. Data collection process will follow the STEPS (STEPwise approach to NCD risk factor surveillance) survey approach, with modification of the sequence of the steps to adapt the data collection to the study context. Data collection involves 3 main steps: (1) structured interviews with questionnaires, (2) anthropometric measurements, and (3) biochemical measurements.

Results: As of December 2021, the recruitment process was completed, with 5072 eligible individuals participating in the data collection; however, data analysis is pending. Results are expected to be fully available in mid-2022.

Conclusions: The cascade of care will allow us to identify leakages in the system as well as the unmet need for care. Identifying gaps in the health system is vital to improve efficiency and effectiveness of its performance. This study protocol and its expected results will help implementers and policy makers to assess scale-up and adapt strategies for T2D and HT care in Cambodia.

Trial Registration: International Standard Randomised Controlled Trials Number (ISRCTN) registry ISRCTN41932064; https://www.isrctn.com/ISRCTN41932064

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KEYWORDS
diabetes; hypertension; cascade of care; implementation research; care models; population-based survey; continuum of care

Introduction

Globally, cardiovascular diseases (CVDs) are responsible for the death of 17.9 million people annually, accounting for 31% of all deaths [1]. More than 75% of deaths attributable to CVDs occur in low- and middle-income countries (LMICs), where primary health care (PHC) settings generally do not perform well in the early detection, diagnosis, and monitoring of type 2 diabetes (T2D) and hypertension (HT), which are the leading risk factors for CVDs [1,2]. In regions where early diagnosis and care are not available or inadequate, T2D and HT-related complications—including CVDs, kidney disease, neuropathy, blindness, and lower-extremity amputation—are a significant cause of morbidity and mortality among people with T2D or HT or both [3,4]. The resulting complications will increase health care costs and pose challenges to population health, socioeconomic development, and health systems [5,6], negatively affecting country's effort to achieve universal health coverage [7]. Globally, adult populations with HT and T2D had increased from 594 million to 1.13 billion between 1975 and 2015 [8] and from 4.7% to 8.5% between 1980 and 2014 (with approximately 422 million living with T2D in 2014), respectively [2]. Access to a lifelong continuum of care is therefore critical for those living with T2D or HT or both as well as for the prevention of CVDs [9]. The World Health Organization Package of Essential Noncommunicable Disease Interventions (WHO PEN) offers substantial international support for PHC services to include care for T2D and HT in LMICs [10].

In Cambodia, CVDs were estimated to account for 24% of the total deaths in 2018 [11], and in 2016 the prevalence rates of T2D and HT were 9.6% and 14.2%, respectively, among adult population between the ages of 18 and 69 years [12]. This seems a significant increase, as the prevalence of T2D between ages 25 and 64 was only 2.9% in 2010 [12]. However, integrated care for T2D and HT in the Cambodian PHC system remains limited [13]. More than two-thirds of the population have never had their blood glucose measured, and more than half of the population with T2D is not receiving treatment [12,14]. The proportion of patients with T2D accessing treatment is low, with few achieving recommended treatment targets [15].

The response to these T2D and HT epidemics requires concerted effort from both global health governance and Cambodia's health system. Cambodia has a pluralistic health system, with a public health care system operated by the Ministry of Health, complemented by many private health care services that mainly offer outpatient curative care, operating largely without sufficient steering and coordination from the government [16]. The government's public health care system was established based on a district health system model, following the PHC approach. With regard to the care for T2D and HT in the public health care system, the following 3 care models are being scaled up: (1) a *hospital-based model*, (2) a *health center–based model*, and (3) a *community-based model*.

The hospital-based model is a standard care model for T2D and HT that is available at district or provincial referral hospitals as part of outpatient consultation. These referral hospitals provide

ambulatory care and support the health centers in treating serious cases. Health centers are allowed to take care of mild or stable cases without complications. The referral hospitals will treat serious cases [13]. In 2018, the Ministry of Health added a second component to this standard care: 29 district and provincial referral hospitals (out of 117) provided exclusive health care services for patients with T2D or HT or both in a separate section, giving explicit attention to these conditions [17].

The health center–based model has been given increasing attention by the Ministry of Health with support from the World Health Organization through the adoption of the WHO PEN for PHC [10]. The National Standard Operating Procedure for T2D and HT Management in Primary Care was developed out of the WHO PEN and approved in 2019 to strengthen implementation of the integrated basic care for T2D and HT in the PHC system. In this health center–based model, health center staff are trained to do screening, provide follow-up care for patients with T2D or HT or both with mild and stable conditions (with diagnosis only undertaken at the referral hospital), and offer health education and counseling on healthy behavior as part of screening for CVD risk factors [13]. With mild HT cases, health center staff are allowed to initiate treatment. At the health center level, care for both T2D and HT is described in a national clinical guideline on the minimum package of activities specified for health centers [18]. Yet, in practice, implementation of this guideline is not as complete as intended because the public health care system has not yet been substantially reoriented from primarily addressing acute health needs toward continuing care for chronic conditions. The public health system currently focuses on communicable diseases (HIV and AIDS, tuberculosis, malaria, diarrhea, and respiratory diseases) and maternal and child health [19]. In early 2020, only 86 health centers (out of 1221) implemented the WHO PEN program since its pilot in 2015 [17].

The community-based model is predominantly run by a Cambodian nongovernmental organization called MoPoTsyo that operates Peer Educator Networks with 4 main key services for patients with T2D or HT or both. These services include (1) self-management training through peer educator visits, (2) laboratory tests, (3) physician consultations, and (4) low-cost medicines delivered through a revolving drug fund program to the members in the network in 8 out of 24 provinces across the country. By 2019, 255 peer educators have been trained to serve over 40,000 patients [20]. In this community-based model, peer educators, who are patients with T2D or HT or both themselves, have been trained by MoPoTsyo to be educators and counselors on lifestyle change. Peer educators also assist registered patients in the networks to have access to professional medical consultations at the public referral hospitals with which they have partnership agreements [20].

These 3 care models are implemented in isolation with relatively little interaction between each other. There have been few empirical studies on their performance. The question arises as to what extent the 3 care models have performed in providing care to people with T2D or HT or both in Cambodia. Care models that are integrated in terms of shared information and resource

coordination have shown to be effective and efficient in many contexts [21]; however, implementation and scale-up of effective care models for T2D and HT remain limited, especially in LMICs. How well different models perform in contributing to good health outcomes is also not well documented. The outcomes of chronic care are difficult to measure, as such care does not have a clear end point, but requires comprehensive illness management along a continuum of care, from detection and diagnosis for initiating treatment and follow-up to successful management of the illness. This complexity requires a comprehensive framework of measurement to assess the performance of care for T2D and HT.

Inspired by noticeable successes in providing the continuum of care to people living with HIV in Cambodia [22], we adapted the HIV test-treat-retain cascade of care [23] in this study protocol to assess the continuum of care for patients living with T2D or HT or both. This method documents how many patients are lost to follow-up between the stages of testing and diagnosis, linkage with and retention in care, and adherence to treatment and control of health conditions. The cascade-of-care approach outlines the aforementioned sequential steps in long-term care. Recently, this approach has been applied to T2D and HT by pooling secondary data from cross-sectional studies of nationally representative surveys in LMICs [24,25]. This was used to produce cascades of care as an approach to assess the performance of health systems to meet the continuum of care for patients living with T2D or HT or both. Two studies, one in the United States and the other in South Africa, developed and field tested the cascade of care for T2D and HT [26,27]. Their analysis was mainly based on extracted secondary data from broader nationally representative surveys, not specifically designed for this purpose.

Given that Cambodia implements T2D and HT services through 3 different care models, we propose the cascade-of-care approach to assess the performance of these care models along the continuum of care. We will do so using primary data collection. This study protocol aims to serve as a tool to generate the cascades of care for T2D and HT for the 3 care models using the primary data of a population-based survey. The specific aims are as follows:

- To generate the cascades of care for T2D for (1) hospital-based care, (2) health center–based care (WHO PEN), (3) community-based care (Peer Educator Network), and (4) coexistence of 1, 2, and 3;
- To generate the cascades of care for HT for (1) hospital-based care, (2) health center–based care (WHO PEN), (3) community-based care (Peer Educator Network), and (4) coexistence of 1, 2, and 3;
- To compare the cascades of care for T2D between the care models 1-4;
- To compare the cascades of care for HT between the care models 1-4.

Methods

Study Design

This study protocol is part of a larger population-based survey—the SCUBY (Scale up diabetes and hypertension care for vulnerable people in Cambodia, Slovenia and Belgium) project [28], which includes other substudies focusing on (1) the health status of people aged 40 and over and the existence of comorbidities, (2) health care utilization and health care expenditure among people aged 40 and above and people living with T2D or HT or both, (3) the lifestyle and knowledge of T2D and HT among people living with T2D or HT or both, and (4) the self-management and social support for people living with T2D or HT or both.

To meet the aforesaid specific aims, 5 operational districts (ODs) in different provinces will be purposefully selected out of 103 ODs across the country. The selection is based on a mapping exercise conducted in the SCUBY project. Only in the OD Daunkeo the 3 care models coexist. The OD Samrong in a bordering province hosts a typical noncommunicable disease (NCD) clinic at the referral hospital (the WHO PEN and Peer Educator Network are not there yet). The OD Kong Pisey does not have the WHO PEN and the NCD clinic at the referral hospital (only the Peer Educator Network of MoPoTsyo exists—with relatively strong network). The OD Pearaing is one of the ODs piloting the WHO PEN and started implementing the program since 2015. At the time of study, 8 of 9 health centers have implemented the WHO PEN. The OD Sotr Nikum is historically and significantly influenced by the financial aid of various development partners and nongovernmental organizations—contextual factor is a focus. The referral hospital in this OD has a Chronic Disease Clinic, where people with T2D or HT or both and those with HIV seek treatment and care [29]. At the time of study, 5 of 25 health centers have implemented the WHO PEN. Table 1 shows the existence of care provision for T2D and HT in each OD.

Table 1. Selected provinces and ODs[a] with different types of care models.

OD name	Province	Existing care provision	Care model
OD Samrong	Oddar Meanchey	NCD[b] clinic at the referral hospital	Hospital-based care
OD Pearaing	Prey Veng	NCD clinic[c] + WHO PEN[d] (high coverage)	Health center–based care
OD Sotr Nikum	Siem Reap	NCD clinic[c] + WHO PEN (low coverage)	Health center–based care with context
OD Kong Pisey	Kampong Speu	Peer Educator Network[e]	Community-based care
OD Daunkeo	Takeo	NCD clinic + WHO PEN + Peer Educator Network	Coexistence of care

[a]OD: operational district.

[b]NCD: noncommunicable disease.

[c]In the WHO PEN implementation arrangement, the referral hospital in the OD supports the health centers in providing the secondary care.

[d]WHO PEN: World Health Organization Package of Essential Noncommunicable Disease Interventions.

[e]The Peer Educator Network arranges a medical consultation for their registered patients once a week at the referral hospital in the OD.

This population-based survey includes 2 questionnaires (Multimedia Appendices 1 and 2). One questionnaire is directed at household heads and inquires about the household's socioeconomic status, member characteristics, general health of the household members, and their access to health care and health-related expenditure. The other questionnaire is for eligible adults (ie, adults aged ?40) of the selected households and inquires about their sociodemographic information, health status and comorbidity, quality of life, health care utilization, social support, behavioral measurements, and knowledge of T2D and HT for known patients with T2D or HT or both in particular. Known patients with T2D or HT or both are also asked about their medical adherence and decision-making power over diet.

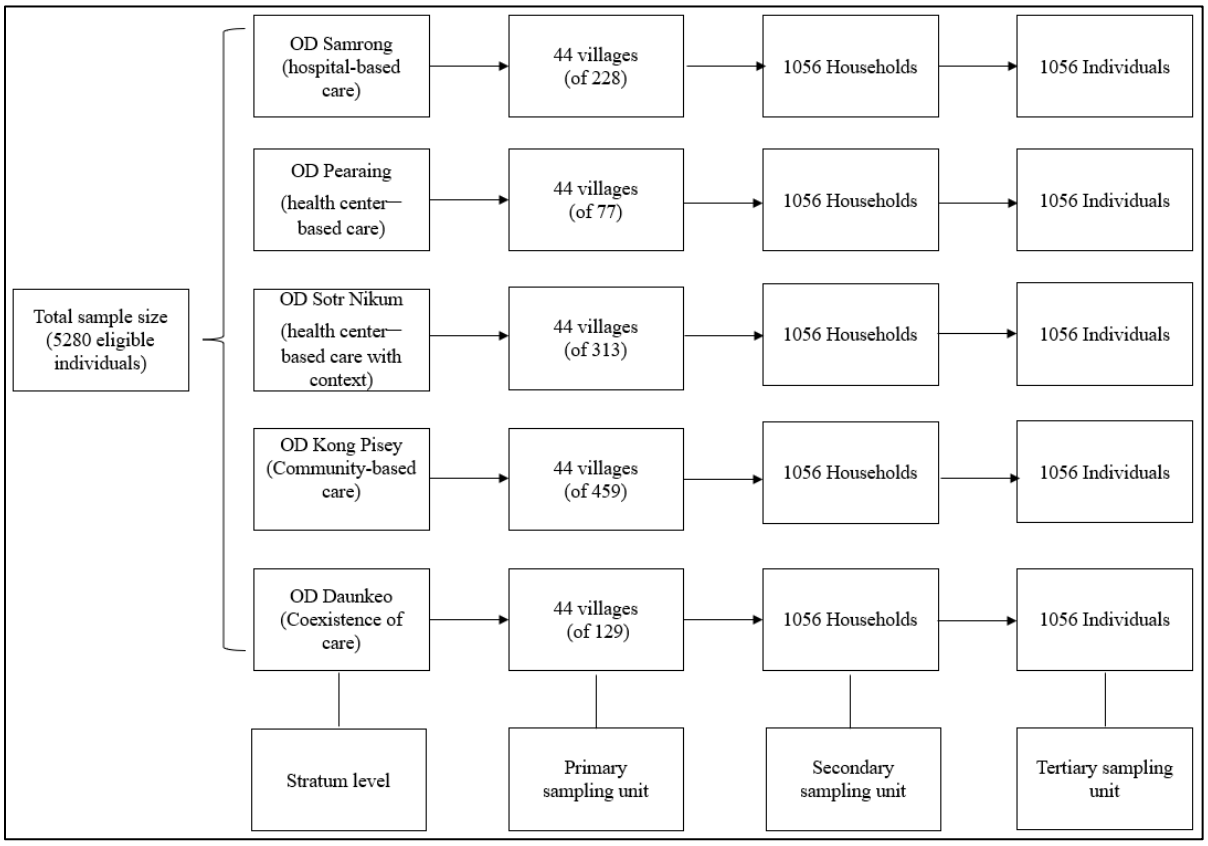
Sampling and Sample Size

This population-based survey follows a multistage stratified random cluster sampling [30]. For the sampling procedure, each OD is considered as a stratum due to the care model present (Table 1). Based on rules of stratification, each stratum is theoretically independent from one another, and its selection can be based on the aforementioned specific aims [30]. In each stratum, clusters of primary sampling units (villages) will be randomly sampled.

Based on the multistage stratified random cluster sampling, 3 stages of stratification are applied, and in each stage randomization is employed. ODs are the strata, and health centers impacted by the types of care models are selected. For the first stage of stratification, sampling with equal probability (equal probability selection method) will be used to determine the number of villages under the catchment areas of the impacted health centers in each OD. This equal selection is also made to ensure oversampling for some ODs. If using proportionate allocation of the sample units across the ODs, the sample selected from the ODs representing certain types of care models would be too low to have enough statistical power for the analyses. In this survey, disproportionate allocation is done to randomly select equal-sized samples in the 5 ODs [30]. For the second stage of stratification, households having adult(s) aged 40 and above (secondary sampling units) in the selected villages are selected and listed. Systematic random sampling is used to select the households from each village. For the third stage of stratification, only 1 individual meeting the eligibility criteria (described later) is randomly selected from each household to reduce the clustering effect. Thus, 1 eligible

individual is selected from each household, making the total sample size of eligible individuals the same as the sample size of households (Figure 1).

Figure 1. Flow of the sampling frame.



The sample size of households in all the selected 5 ODs is calculated based on the following formula [30]:

$$n_h = (z^2)(r)(1-r)(f)(k)/(p)(\gamma)(e^2)$$

where n_h is the parameter to be calculated and the sample size in terms of the number of households to be selected; z is the statistic that defines the level of confidence desired (1.96 for the 95% level of confidence); r is an estimate of a key indicator to be measured by the survey (the key indicator being T2D prevalence—this r being 0.1 according to 10% of T2D prevalence among adults aged 40 and over—the national STEPS survey 2016 [12]); f is the sample design effect (1.5 used in accordance with the national STEPS survey 2016 [12] and the Cambodian demography and health survey 2014 [19]); k is a multiplier to account for the anticipated rate of nonresponse (1.2 for 20% anticipated rate, as used in the national STEPS survey 2016 [12]);

p is the proportion of the total population accounted for by the target population and upon which the parameter r is based (0.24 for 24% [31]); γ is the average household size (4.6 for the number of persons per household in the selected provinces—census 2019 [32]); and e is the margin of error to be attained (0.01 for the level of precision at 10% of r). While HT prevalence is higher, T2D prevalence of 10% [12] is used as the main key indicator of interest to determine the sample size, which is important for the cascade of care. Based on the aforementioned formula, the total sample size would be 5637 households, including 20% of anticipated nonresponse rate. Enlarging the sample size to include enough patients to assure significant differences for the detection of the number of patients with T2D having blood glucose under control would increase the budget 5-fold, which is not feasible. Taking feasibility and budget constraint into consideration, a fixed cluster size of 24 households per village, with 44 villages randomly selected in each OD, will be applied for the sake of controlling the total sample size and interviewer workloads [30]. Thus, a cluster size of 24 households per village over the total villages of 220 would yield the total sample size of 5280 households (also equal 5280 eligible individuals).

Target Population and Recruitment Strategy

Adults aged 40 and above are the target population. This age group is appropriate for screening for T2D and HT according to the national standard operating procedure for T2D and HT management in primary care [13]. Other recruitment criteria include (1) being usual members of the household, having stayed in the household the night before the interview or not been absent for more than 6 months; (2) being physically and mentally capable of answering the questions; and (3) providing consent to participate in the study.

The starting point of recruitment is a list of all the eligible households in the selected villages (Multimedia Appendix 3). The list will be constructed by a listing team with support of a local authority, listing households in the selected village having at least one adult aged 40 and above. When a household is selected, 1 household member aged 40 and above will be selected for inclusion in the study. If the selected eligible individual is not present in the household during the first-time visit, 2 repeated callbacks and follow-up will be applied. Only if all these attempts fail, the selected participants would be replaced: the respective households would be replaced with the next household in a row of the eligible household list constructed. The replacement household would be selected following the procedure described earlier. If the eligible individuals can be contacted but express refusal to participate in the study after a few times of failed explanation, the individuals as well as the households would be dropped from the study.

Data Collection Procedure

Data collection process will follow the STEPS survey approach [33], with modification of the sequence of the steps to adapt the data collection to the study context. There are 3 main steps of data collection: (1) structured interviews with questionnaires, (2) anthropometric measurements, and (3) biochemical measurements. The modification will entail data collectors taking anthropometric measurements and biochemical measurements of the eligible individuals before administering the 2 sets of questionnaires.

The anthropometric measurements include measurements of blood pressure, body weight, height, and waist and hip circumferences. For blood pressure measurements, participants will rest at least 15 minutes prior to the measurement and 3 readings will be taken 3 minutes apart from one another, with the left arm recommended for the measurement [33]. For the biochemical measurements, testing of fasting blood glucose (FBG) will be carried out for all the participants (Multimedia Appendix 4) and glycated hemoglobin A_{1c} (HbA_{1c}) and creatinine for known participants with T2D or participants having FBG of 126 mg/dl or more (Multimedia Appendix 5). Data will be digitally collected using the KoBoToolbox system developed by the Harvard Humanitarian Initiative [34].

For the point-of-care measurement of FBG (capillary plasma value), the On Call Plus (ACON USA), which is compliant with the US Food and Drug Administration regulations [35], will be used. It is widely used in the WHO PEN program in Cambodia. The HemoCue HbA_{1c} 501 System, whose quality is ensured by the International Federation of Clinical Chemistry and Laboratory Medicine and the National Glycohemoglobin Standardization Program [36], will be employed as a point-of-care test for HbA_{1c}. Regarding the anthropometric measurement, Omron JPN500, which is clinically validated by the Association for the Advancement of Medical Instrumentation and European Society of Hypertension [37], will be used to measure blood pressure. A flat weight scale (Seca-803), height measuring system (Seca-217), and ergonomic circumference measuring tape with extra waist-to-hip-ratio calculator (Seca-203) will be used to measure weight, height, and waist and hip circumferences of the participants, respectively. Seca is internationally recognized as producing highly accurate scales equipped with high-precision measuring technology [38].

Statistical Analysis Plan

For the analysis plan, 6 cascade bars, as explained in Tables 2 and 3, will be used to generate the cascades of care for T2D and HT, respectively. A fixed denominator approach will be followed as it enables readers to see the leakages between stages of the continuum of care [39]. The denominator is the total number of eligible individuals aged 40 and above having T2D (for the T2D cascade of care) and HT (for the HT cascade of care). We will produce the cascade of care

for T2D and HT for the selected ODs hosting different existing care models. These cascades of care—in essence, a series of bar charts—will subsequently be translated into cumulative probabilities. The bivariate analysis will be used to identify potential factors associated with the outcome variables—prevalence, testing, diagnosis, in care, in treatment, and under control bars. At the initial stage, the chi-square test will be used to determine the association between explanatory variables and outcome variables. The explanatory variables will include participants' age, sex, marital status, educational level, household wealth quintile, health care utilization, and care model setting. Variables with statistically significant level (*P*<.2) will be included in a multiple logistic regression model. In addition to the aforementioned variables, BMI, lifestyle, knowledge of T2D and HT, self-management, and social support will be included in the multiple logistic regression model for the outcome variables—in care, in treatment, and under control bars [24,25]. In the multiple logistic regression model, the backward elimination method will be used. The process will start with all the identified explanatory variables. Then, variables with the highest *P* value will be eliminated from the model one by one at a time. The process will be repeated until all the variables in the model are statistically significant with a cut-off point of *P* value <.05. This knowledge will allow us to identify which characteristics stimulate the probability of not reaching the next step in the cascade of care, thereby identifying patient groups not adequately reached.

Table 2. Defined groups of participants for each bar of the cascade of care for T2D[a].

Bars of the cascade of care for T2D	Definitions	Questions extracted for analysis
1. Prevalence of the target population living with T2D	• Participants having biochemical measurement of FBG[b] (capillary plasma value) ≥126 mg/dl (7 mmol/L) and HbA1c[c] level ≥6.5% [24, 40, 41]	• Measurement of FBG • Measurement of HbA1c
	• or Participants reporting use of drugs for T2D, irrespective of their biomarker values	• Have you ever been told by a doctor or other health worker that you have T2D?
2. Number of the target population with T2D ever tested for T2D	• Classified patients with T2D having had FBG tested in the last 3 years	• Have you ever had your blood glucose tested in the last 3 years?
3. Number of those tested ever diagnosed for T2D	• Tested patients with T2D reporting ever being told by a doctor	• Have you ever been told by a doctor or other health worker that you have T2D?

	or other health worker as having T2D	
4. Number of those diagnosed in care	• Diagnosed patients with T2D reporting getting treatment/care for their conditions at least once in the past 12 months	• Did you get treatment/care for your T2D condition in the past 12 months?
5. Number of those in care receiving treatment	• In care patients with T2D reporting using drugs for T2D or insulin in the past 2 weeks **or** in care patients with T2D reporting following advice to lose weight, stop smoking, do physical exercise, and be on special prescribed diet	• Are you currently receiving any of the following treatment/advice for your T2D condition prescribed by a doctor or health care worker? • Insulin or drugs (medication) that you have taken in the past 2 weeks • Are you currently receiving any of the following treatment/advice for your T2D condition prescribed by a doctor or health care worker? • Special prescribed diet and • advice to lose weight and • advice to stop smoking and • advice to start or do more physical exercise
6. Number of those receiving treatment being under control	• In treatment patients with T2D having HbA1c level <8% [24]	• Measurement of HbA1c for the known T2D

[a]T2D: type 2 diabetes.

[b]FBG: fasting blood glucose.

[c]HbA_{1c}: glycated hemoglobin A_{1c}.

Table 3. Defined groups of participants for each bar of the cascade of care for HT[a].

Bars of the cascade of care for HT	Definitions	Questions extracted for analysis
1. Prevalence of the target population living with HT	• Participants having systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg [12] or	• Measurement of blood pressure (mean of the second and third readings)
	• Participants reporting use of drugs for HT, irrespective of their blood pressure values	• Have you ever been told by a doctor or other health worker that you have HT?
2. Number of the target population with HT ever tested for HT	• Classified patients with HT having had a blood pressure measured in the last 3 years	• Have you ever had your blood pressure measured in the last 3 years?
3. Number of those tested ever diagnosed for HT	• Tested patients with HT reporting ever being told by a doctor or other health worker as having HT	• Have you ever been told by a doctor or other health worker that you have HT?
4. Number of those diagnosed in care	• Diagnosed patients with HT reporting getting treatment/care for their conditions at least once in the past 12 months	• Did you get treatment/care for your HT condition in the past 12 months?
5. Number of those in care receiving treatment	• In care patients with HT reporting using drugs for HT in the past 2 weeks or	• Are you currently receiving any of the following treatment/advice for your HT condition prescribed by a doctor or other health worker? • Drugs (medication) that you have taken in the past 2 weeks

	• In care patients with HT reporting following advice to lose weight, stop smoking, do physical exercise, and reduce salt intake	• Are you currently receiving any of the following treatment/advice for your HT condition prescribed by a doctor or other health worker? • Advice to reduce salt intake and • advice to lose weight and • advice to stop smoking and • advice to start or do more physical exercise
6. Number of those receiving treatment being under control	• In treatment patients with HT having systolic blood pressure <140 mmHg and diastolic blood pressure <90 mmHg [12]	• Measurement of blood pressure (mean of the second and third readings) for the known HT

[a]HT: hypertension.

Because of the multistage stratified random cluster sampling, a 3-stage weighting procedure will be applied to account for (1) the fixed number of villages selected in each OD, (2) the fixed number of households selected in each village, and (3) the number of household members aged 40 and above in each selected household [25,30]. The statistic program Stata 14.2 (StataCorp) [42] will be used to perform the quantitative analyses.

Variables used to generate the cascade of care for T2D and HT are shown in Tables 2 and 3, respectively. The explanatory variables are detailed in Multimedia Appendix 6 [43-47].

The population in the catchment areas is not confined to seek care only in the designated public health facility. To address this, we will also collect patient registry data from the public health facilities in the study setting with regard to patients receiving treatment for triangulating the care model selected.

Ethical Approval

This study protocol has been approved by the National Ethics Committee for Health Research in Cambodia (reference number 105 NECHR) and by the Institutional Review Board of Institute of Tropical Medicine (Antwerp; reference number 1323/19). The study is also registered as part of the SCUBY protocol at the International Standard Randomised Controlled Trials Number (ISRCTN) registry, number ISRCTN41932064 (first date of publication February 3, 2020).

Results

Data collection was carried out from mid-July to mid-October 2020. By June 2021, the data cleansing process was finished and cleaned data were properly managed as data sets. As of December 2021, the recruitment process was completed, with 5072 eligible individuals participating in the data collection; however, data analysis is pending. Results are expected to be fully available in mid-2022.

Discussion

This protocol aims to assess the performance of the 3 dominant care models for T2D and HT through the cascade of care framework, using the population-based survey. This framework will allow us to identify the leakages in the system and the unmet need for care [24]. In addition, we will be able to better understand the diversity in service models across the country by comparing 3 different care models. The design of this study, using large-scale primary data, is unique. The evidence generated from this large-scale survey of more than 5000 households will stimulate policy-relevant analysis that is informative to the existing care for T2D and HT provided by the 3 main care models and act as baseline data for progress monitoring purposes [24]. Identifying gaps in the health system is vital to improve efficiency and effectiveness of its performance.

The strengths of the study are primary data collection, a large sample size, and multiple types of data. This allows us to assess multiple outcomes and to link them with other indicators such as health care utilization, health seeking behavior, morbidity profile, and sociodemographic characteristics. The limitations relate to its complicated set up. The multilevel stratification and the collection of multiple types of (outcome) data make the research design and practical organization difficult. The clustering on more than 2 levels and the different outcomes make it challenging to calculate an ideal sample size following all regulations. We have addressed this by seeking optimal balance between maximizing precision and minimizing costs for feasibility. The purposive selection of ODs based on the mapping of existing care models limits the generalizability of results. However, through randomization within ODs, we will strive for maximum internal validity.

Despite these limitations, this study protocol has a large potential to produce evidence of the performance of different care models for T2D and HT in Cambodia. These insights will help implementers and policy makers to assess scale up and adapt strategies. This is of vital importance owing to the increasing burden of CVDs, T2D, and HT in the country [5,12,13]. As many LMICs struggle with similar burdens of disease and similar structural problems in their health systems, the study protocol and its expected results are also useful for monitoring and scaling up of care for highly prevalent chronic diseases across the globe.

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Data Availability

The data sets generated during or analyzed during this study are available from the corresponding author on reasonable request.

Authors' Contributions
All authors took part in conceptualizing the study design. VT prepared the original draft. EW, JvO, VB, WVD, and PI provided feedback on the drafts. All authors read and approved the final manuscript.

Conflict of Interest
None declared.

Multimedia Appendix 1
Questionnaire about household information. [Multimedia Appendix 1]

Multimedia Appendix 2
Questionnaire about eligible individual information. [Multimedia Appendix 2]

Multimedia Appendix 3
Sample list of the eligible households in each village. [Multimedia Appendix 3]

Multimedia Appendix 4
Sample record book of anthropometric and biochemical measurements of all the eligible individuals. [Multimedia Appendix 4]

Multimedia Appendix 5
Sample record book of HbA1c and Creatinine measurements of known T2D patients or the eligible individual having FBG ?126 mg/dl. [Multimedia Appendix 5]

Multimedia Appendix 6
Identified explanatory variables. [Multimedia Appendix 6]

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Abbreviations

CVD: cardiovascular disease
FBG: fasting blood glucose
HbA_{1c}: glycated hemoglobin A_{1c}
HT: hypertension
LMIC: low- and middle-income country
NCD: noncommunicable disease

OD: operational district
PHC: primary health care
SCUBY: Scale up diabetes and hypertension care for vulnerable people in Cambodia, Slovenia and Belgium
STEPS: STEPwise approach to NCD risk factor surveillance
T2D: type 2 diabetes
WHO PEN: World Health Organization Package of Essential Noncommunicable Disease Interventions

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Chapter 5: Evaluation of Diabetes Care Performance in Cambodia Through the Cascade-of-Care Framework: Cross-Sectional Study

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Abstract

Background: Cambodia has seen an increase in the prevalence of type 2 diabetes (T2D) over the last 10 years. Three main care initiatives for T2D are being scaled up in the public health care system across the country: *hospital-based care*, *health center–based care*, and *community-based care*. To date, no empirical study has systematically assessed the performance of these care initiatives across the T2D care continuum in Cambodia.

Objective: This study aimed to assess the performance of the 3 care initiatives—individually or in coexistence—and determine the factors associated with the failure to diagnose T2D in Cambodia.

Methods: We used a cascade-of-care framework to assess the T2D care continuum. The cascades were generated using primary data from a cross-sectional population-based survey conducted in 2020 with 5072 individuals aged ≥40 years. The survey was conducted in 5 operational districts (ODs) selected based on the availability of the care initiatives. Multiple logistic regression analysis was used to identify the factors associated with the failure to diagnose T2D. The significance level of $P<.05$ was used as a cutoff point.

Results: Of the 5072 individuals, 560 (11.04%) met the definition of a T2D diagnosis (fasting blood glucose level ≥126 mg/dL and glycated hemoglobin level ≥6.5%). Using the 560 individuals as the fixed denominator, the cascade displayed substantial drops at the testing and control stages. Only 63% (353/560) of the participants had ever tested their blood glucose level in the last 3 years, and only 10.7% (60/560) achieved blood glucose level control with the cutoff point of glycated hemoglobin level<8%. The OD hosting the coexistence of care displayed the worst cascade across all bars, whereas the OD with hospital-based care had the best cascade among the 5 ODs. Being aged 40 to 49 years, male, and in the poorest category of the wealth quintile were factors associated with the undiagnosed status.

Conclusions: The unmet needs for T2D care in Cambodia were large, particularly in the testing and control stages, indicating the need to substantially improve early detection and management of T2D in the country. Rapid scale-up of T2D care components at public health facilities to increase the chances of the population with T2D of being tested, diagnosed, retained in care, and treated, as well as of achieving blood glucose level control, is vital in the health system. Specific population groups susceptible to being undiagnosed should be especially targeted for screening through active community outreach activities. Future research should incorporate digital health interventions to evaluate the effectiveness of the T2D care initiatives longitudinally with more diverse population groups from various settings based on routine data vital for integrated care.

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KEYWORDS
diabetes; cascade of care; implementation research; population-based survey; care continuum; mobile phone

Introduction

Background

In 2021, globally, 1 in 10 adults aged 20 to 79 years was living with type 2 diabetes (T2D) [1]. Similar to other countries in the Western Pacific region—the World Health Organization (WHO) region with the highest number of adults living with T2D (206 million) [1]—Cambodia has been severely affected by the T2D epidemic. In 2016, the prevalence rate of T2D in this lower–middle-income country was 9.6% among adults aged 18 to 69 years, signifying a significant increase compared with the prevalence rate in 2010 (2.9% among adults aged 25-64 years) [2]. As a response to the increased burden of chronic conditions, including T2D, across the globe, the WHO adopted the innovative care for chronic conditions (ICCC) framework as a road map for countries, regardless of income level, to transform their health systems toward better care for chronic conditions [3].

The incurable nature of T2D, along with its chronicity and silent progression, requires the condition to be diagnosed as early as possible and managed properly and promptly on a regular basis by patients, caregivers, and health care professionals to prevent or delay complications [3]. Care for T2D relies not only on medical interventions provided by health care professionals but also on high-quality and continuous self-management [4]. A systematic review shows that the quality of T2D care in low-and middle-income countries (LMICs) in Asia and the Middle East has been reported to be limited, with the care goals recommended in the evidence-based guidelines not being met [5]. The WHO promotes the adoption of integrated care for disease management in the health system as outlined in the ICCC framework [3], which is evidence based in improving blood glucose level control [6,7], to fill the gaps.

Likewise, care for T2D in Cambodia has been limited among the population at risk and people living with T2D. Many adults (more than two-thirds of the population) have never had their blood glucose level tested, and more than half of those living with T2D are not receiving treatment [2].

Cambodia's health system is pluralistic—both public providers and private providers (including nonprofit organizations) provide care for T2D in the country. The ministry of health is in charge of the public health providers, which are organized on a district health system model and guided by the primary health care approach [8]. In this model, an operational district (OD) usually comprises a referral hospital providing secondary care and 10 to 25 health centers providing primary care with support from community health workers. The public providers mainly cover health prevention activities by providing primary health care for people with infectious diseases (such as HIV infection and AIDS, tuberculosis, and malaria) and focusing on maternal and child health, leaving care for chronic conditions, including T2D, to be provided mainly by private providers [9]. A self-reported survey on availability of T2D services at primary care facilities indicated that only approximately 1 in 5 health centers reported providing T2D services [10].

To improve the availability of integrated care for T2D, three main care initiatives for T2D are currently being scaled up across the 103 ODs in Cambodia [11]: (1) *hospital-based care*, (2) *health center–based care*, and (3) *community-based care*. In 2019, the ministry of health approved a national standard operating procedure for the management of T2D and hypertension in primary care in an attempt to integrate these 3 care initiatives for the T2D and hypertension care continuum in which health centers provide continuity and coordination across the care levels in the OD [11]. This standard operating procedure was adapted from the WHO package of essential noncommunicable disease interventions (WHO PEN) [12]—we refer to health centers implementing the standard operating procedure as the WHO PEN health centers.

Hospital-based care is standard care at the referral hospitals that provide ambulatory care for serious or complicated T2D cases. In 2018, with support from the ministry of health, 29 of the 117 referral hospitals provided exclusive care for T2D and hypertension at separate noncommunicable disease (NCD) clinics [13]. Health center–based care is implemented at the WHO PEN health centers. They are allowed to take care of mild or stable T2D cases without complications, with the diagnosis confirmed and treatment initiated at the referral hospital. In early 2020, only 86 of the 1221 health centers had implemented the WHO PEN program [13]. Community-based care is implemented through peer educator networks run by a Cambodian nongovernmental organization called MoPoTsyo. The networks offer (1) self-management support to patients through peer educators who have been diagnosed with T2D themselves, (2) laboratory tests, (3) physician consultations, and (4) low-cost medicines through a revolving drug fund program [14]. Each peer educator is responsible for a health center's catchment area, with populations ranging from 10,000 to 20,000 [8]. By 2019, MoPoTsyo had 255 peer educators trained to serve >40,000 patients [14]. Detailed descriptions of the 3 care initiatives have been provided in a study protocol [15].

The coexistence of the 3 care initiatives—combining hospital-, health center–, and community-based care components—in an OD could potentially produce the ideal context for integrated care as described in the ICCC framework [3]. However, for the care initiatives to be integrated and thus for these 3 care initiatives to strengthen each other, necessary information has to be shared, and resources have to be coordinated in an effective and efficient manner [16].

To our knowledge, no empirical study has assessed the performance of the aforementioned 3 care initiatives—either individually or in coexistence—across the T2D care continuum in Cambodia. We used the test-treat-retain cascade of care as adapted from the HIV program to assess the T2D care continuum [17]. This method allowed us to document how many patients were lost along the care continuum with regard to testing, diagnosis, retention in care, receiving treatment, and achieving good control of their health condition. In other LMICs, limited existing studies have pooled secondary data from cross-sectional surveys to generate countrywide cascades of care [18-20] as an approach to assess health system performance to meet the T2D care continuum goals. A systematic assessment of the performance of the different care initiatives—either individually or in coexistence—currently being scaled up in Cambodia is not yet available.

Objectives

This study aimed to address the research gap by assessing the performance of the aforementioned care initiatives either individually or in coexistence with the cascade-of-care framework using primary data from a population-based survey and determining the factors associated with the undiagnosed status of T2D among the population.

Methods

Study Design

The study was part of a population-based survey conducted in 2020. It was a cross-sectional study involving 5072 individuals aged ≥40 years [15]. A detailed explanation of the study design was included in the study protocol [15].

Study Setting

Five ODs were purposively selected to assess the performance of the aforementioned care initiatives—individually or in coexistence. OD Samrong in Oddar Meanchey province provided hospital-based care at the NCD clinic of the referral hospital—the only public provider for T2D care in the OD at the time of the study. People with T2D visited the physician for a medical consultation (prescriptions and medicines were provided) on a monthly appointment basis. The second selected OD was OD Pearaing in Prey Veng province. This OD began implementing health center–based care in 2015. Assigned staff at the WHO PEN health centers receive training to perform screening, provide follow-up care for mild and stable T2D cases, and offer health education and counseling on healthy behavior as part of cardiovascular disease risk factors management [11]. By structural design, the NCD clinic at the referral hospital is required to support the WHO PEN health centers. In this OD, at the time of the study, 8 of the 9 health centers were WHO PEN health centers (high coverage). The third selected OD was OD Sotr Nikum in Siem Reap province. This OD has been historically and substantially influenced by financial aid from various development partners and nongovernmental organizations. At the time of the study, 5 of the 25 health centers in the OD were WHO PEN health centers (low coverage), supported by a chronic disease clinic that provided treatment and care to both people with T2D and hypertension and those with HIV infection [21]—the clinic was essentially the NCD clinic of the referral hospital. Therefore, we consider this OD the host of health center–based care (with context). The fourth selected OD was OD Kong Pisey in Kampong Speu province. In this OD, the peer educator network provided community-based care. At the time of the study, none of the public providers in this OD formally offered care for people with T2D. MoPoTsyo made arrangements with the referral hospital to provide physician consultations for people with T2D in the network once a week. The fifth selected OD was OD Daunkeo in Takeo province—the only OD found to host all 3 care initiatives together across the 103 ODs in Cambodia. At the time of the study, hospital-based care in this OD was provided at the NCD clinic of the referral hospital,

whereas 8 of the 15 WHO PEN health centers in this OD provided health center–based care. The peer educator network provided community-based care, but the network had already been handed over to the OD health authorities for governance. Table 1 summarizes the study settings.

Table 1. Selected provinces and operational districts (ODs) with different types of care initiatives.

Name of OD	Province	Existing care provision	Care initiative
Samrong	Oddar Meanchey	NCD[a] clinic at referral hospital	Hospital-based care
Pearaing	Prey Veng	NCD clinic+WHO PEN[b] (high coverage)	Health center–based care
Sotr Nikum	Siem Reap	NCD clinic+WHO PEN (low coverage)	Health center–based care with context
Kong Pisey	Kampong Speu	Peer educator network	Community-based care
Daunkeo	Takeo	NCD clinic+WHO PEN+peer educator network	Coexistence of care

[a]NCD: noncommunicable disease.

[b]WHO PEN: World Health Organization package of essential noncommunicable disease interventions.

Study Participants and Recruitment

The target study participants were adults aged ≥40 years. This age group was targeted for T2D screening according to the national standard operating procedure [11]. The recruitment was processed via a 3-level procedure. First, within each OD, a list of villages affected by the care initiative was drawn up, and 44 villages were randomly selected. Second, 24 eligible households (ie, those containing at least 1 household member aged ≥40 years) were randomly selected from a list of all eligible households in the selected villages. Within the selected households, potential participants had to be (1) usual members of the household either staying in the house the night before the interview or not being absent for >6 months, (2) physically and mentally capable of answering questions, and (3) well-informed regarding the consent procedure for participation in the study. In the third step, 1 household member meeting the aforementioned eligibility criteria from each randomly selected household was randomly recruited into the study. Each selected participant was interviewed based on a preset questionnaire and their anthropometric measurements (blood pressure, body weight, height, and waist and hip circumferences) and biochemical measurements (fasting blood glucose [FBG] level, glycated hemoglobin [HbA1c] level, and creatinine level) taken. Data were digitally collected using the KoboToolbox system developed by the Harvard Humanitarian Initiative [22].

Measures and Analytical Strategy

Primary Outcome of Interest

The main outcome of interest in this study was the cascade of care consisting of six bars: (1) the *prevalence* bar, (2) the *ever tested or screened* bar, (3) the *ever diagnosed* bar, (4) the *in care* bar, (5) the *in treatment* bar, and (6) the *under control* bar. A fixed denominator approach was used for constructing the cascades of care to identify the leakages between the stages of the care continuum [23]. Table 2 shows the definitions of each bar and describes the sources of the data extracted for the analysis.

Table 2. Definitions of the cascade bars for type 2 diabetes (T2D).

Bars of the cascade of care for T2D and definitions	**Source of data extracted for analysis**
Prevalence of the target population living with T2D	
Participants having biochemical measurement of FBG[a] (capillary plasma value) level ≥126 mg/dL (7 mmol/L) and HbA1c[b] level ≥6.5% [18,24,25]	• Measurement of FBG level • Measurement of HbA_{1c} level
Participants reporting use of drugs for T2D, irrespective of their biomarker values	• Response to the question, *Have you ever been told by a physician or other health worker that you have T2D?*
Number of people in the target population with T2D ever tested for T2D	
Patients classified as living with T2D having had FBG level tested in the last 3 years	• Response to the question, *Have you ever had your blood glucose level tested in the last 3 years?*
Number of those tested ever diagnosed for T2D	
Tested patients with T2D reporting ever being told by a physician or other health worker that they have T2D	• Response to the question, *Have you ever been told by a physician or other health worker that you have T2D?*
Number of those diagnosed in care	

Patients diagnosed with T2D reporting receiving treatment or care for their conditions at least once in the past 12 months	• Response to the question, *Did you get treatment or care for your T2D condition in the past 12 months?*
Number of those in care receiving treatment	

Patients with T2D in care reporting using drugs for T2D or insulin in the past 2 weeks	• Response to the question, *Are you currently receiving any of the following treatments for your T2D condition prescribed by a physician or other health care worker?*
	  • *Insulin*
	  • *Drugs (medication) that you have taken in the past 2 weeks*

Patients with T2D in care reporting following advice to lose weight, stop smoking, perform physical exercise, and be on a special prescribed diet	• Response to the question, *Are you currently receiving all of the following advice for your T2D condition prescribed by a physician or other health care worker?*
	  • *Special prescribed diet*
	  • *Advice to lose weight*
	  • *Advice to stop smoking*
	  • *Advice to start or perform more physical exercise*

Number of those receiving treatment with T2D under control	
Patients with T2D in treatment having HbA1c level <8% [18]	• Measurement of HbA_{1c} level for known T2D

[a]FBG: fasting blood glucose.

[b]HbA1c: glycated hemoglobin.

Secondary Outcomes of Interest

The secondary outcomes of interest were the factors associated with the undiagnosed status of participants living with T2D. We defined *person with undiagnosed status* as a person having biochemical measurements of FBG level ≥126 mg/dL and HbA1c level ≥6.5% in our study but never being told by a physician or other health worker that they had T2D.

Explanatory Variables

The explanatory variables for this analysis included demographic characteristics, socioeconomic status, and the care initiatives (either individually or in coexistence). The demographic characteristics consisted of (1) age in years (40-49, 50-59, or ≥60); (2) sex (male or female); (3)

educational attainment (none, primary school, secondary school, or higher); and (4) socioeconomic status (poorest, poor, medium, rich, or richest), which was measured using a household wealth index. To obtain the household wealth index, each household was interviewed using a 20-item questionnaire adapted from the 2014 Cambodia Demographic Health Survey [26]. This tool has been validated and widely used to classify household socioeconomic class [27]. Finally, the care initiative settings included (1) hospital-based care, (2) health center-based care, (3) health center-based care with context, (4) community-based care, and (5) the coexistence of the 3 care initiatives.

Statistical Analysis

We produced bar charts of the T2D cascades of care in accordance with the definitions provided in Table 2. We used bivariate analyses to compare the proportion of participants living with T2D without a diagnosis by participant characteristics. Subsequently, a multiple logistic regression analysis was used to identify the factors associated with the undiagnosed status. As we had only a limited number of explanatory variables in the bivariate analysis, we included all these variables in our initial multiple logistic regression analysis, regardless of the significance level. We additionally used a backward elimination method. Variables with the highest *P* value were eliminated from the model one by one. We retained all variables with a significance level of $P<.05$ in the final model. The statistical software Stata (version 14.2; StataCorp LLC) was used to perform the statistical analyses [28].

Ethics Approval

This study was approved by the National Ethics Committee for Health Research in Cambodia (NECHR; 105 NECHR) and by the institutional review board of the Institute of Tropical Medicine (Antwerp, Belgium; 1323/19). The study has also been registered as part of the Scale-up Integrated Care for Diabetes and Hypertension (SCUBY) project protocol at the ISRCTN Registry (ISRCTN41932064).

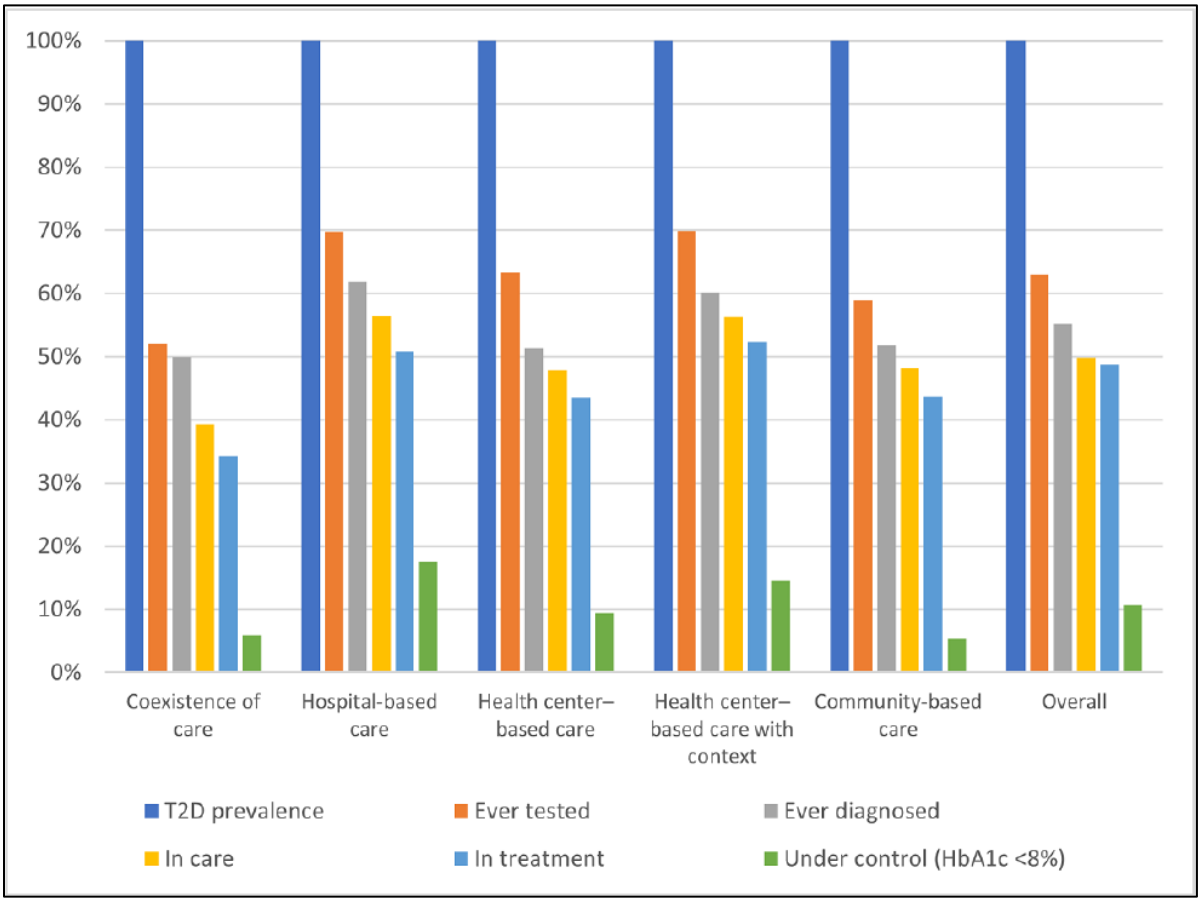
Results

Cascade of Care

Of the 5072 individuals participating in this study, 614 (12.11%) had raised blood glucose level (FBG level ≥126 mg/dL), and 560 (11.04%) met the definition of having T2D (Multimedia Appendix 1). Using the 560 individuals as the fixed denominator, we observed that 2 bars—*ever tested* and *under control*—had a substantial drop. Of the 560 individuals with T2D, only 353 (63%) had ever undergone a blood glucose level test in the last 3 years, 309 (55.2%) had ever been diagnosed as having T2D, 279 (49.8%) had received care in the past 12 months, and 273 (48.8%) had received insulin or antidiabetic medication in the past 2 weeks. In addition, only 130 (47.6%) of the 273 treated participants also received advice regarding a prescribed diet, weight loss, smoking

cessation, and physical exercise. Only 10.7% (60/560) achieved blood glucose level control with the cutoff point of HbA1c level <8% (Multimedia Appendix 1). Figure 1 shows the comparison of the cascades of care by setting with the overall cascade of care.

Figure 1. Type diabetes (T2D) cascade of care by setting in 2020 in Cambodia. HbA_{1c}: glycated hemoglobin.



Participant Characteristics

As can be seen in Table 3, the majority of our study participants with T2D were those aged ≥50 years (476/560, 85%), female (418/560, 74.6%), and with low educational level (primary school level or lower: 490/560, 87.5%). Of the 560 participants living with T2D, 251 (44.8%) were undiagnosed. In this bivariate analysis, we observed that age (*P*<.001) and sex (*P*=.03) were associated with the undiagnosed status of participants living with T2D.

Table 3. Characteristics of the diagnosed and undiagnosed type 2 diabetes cases in 2020 in Cambodia.

Characteristics	Overall (N=560), n (%)	Diagnosed cases (n=309), n (%)	Undiagnosed cases (n=251), n (%)	*P* value
Age (years)				*<.001*[a]
40-49	84 (15)	29 (9.4)	55 (21.9)	
50-59	219 (39.1)	125 (40.4)	94 (37.5)	
≥60	257 (45.9)	155 (50.2)	102 (40.6)	
Sex				*.03*
Male	142 (25.4)	67 (21.7)	75 (29.9)	
Female	418 (74.6)	242 (78.3)	176 (70.1)	
Marital status				.53
Married or living with spouse	373 (66.6)	204 (66)	169 (67.3)	
Widowed or not living with spouse	179 (32)	102 (33)	77 (30.7)	
Never married and never lived together	8 (1.4)	3 (1)	5 (2)	
Educational level				.53
No formal education or less than primary education	164 (29.3)	95 (30.8)	69 (27.5)	
Primary education	326 (58.2)	179 (57.9)	147 (58.6)	
Secondary education or higher	70 (12.5)	35 (11.3)	35 (13.9)	
Household wealth quintile				.45
1 (poorest)	100 (17.9)	48 (15.5)	52 (20.8)	
2	102 (18.2)	54 (17.5)	48 (19.1)	
3	114 (20.3)	67 (21.7)	47 (18.7)	
4	113 (20.2)	67 (21.7)	46 (18.3)	
5 (richest)	131 (23.4)	73 (23.6)	58 (23.1)	
Care initiative				.22
Coexistence of care	102 (18.2)	51 (16.5)	51 (20.3)	
Community-based care	112 (20)	58 (18.8)	54 (21.5)	
Health center–based care	117 (20.9)	60 (19.4)	57 (22.7)	
Health center–based care with context	103 (18.4)	62 (20.1)	41 (16.3)	
Hospital-based care	126 (22.5)	78 (25.2)	48 (19.2)	

[a]Italicization indicates values that met the significance threshold (*P*<.05).

In the multiple logistic regression analysis (Table 4), being aged 40 to 49 years was associated with higher odds of not receiving the T2D diagnosis (adjusted odds ratio [AOR] 3.2, 95% CI1.9-5.5; *P*<.001) compared with those aged ≥60 years. Male participants with T2D displayed higher odds of not being diagnosed (AOR 1.7, 95% CI 1.1-2.5; *P*<.001) than female participants living with T2D.

We also observed that being in the poorest category of the wealth quintile was associated with having higher odds of not being diagnosed with T2D (AOR 2.3, 95% CI 1.3-4.2; *P*=.005) than those in the richest category. Finally, the care initiative setting was also associated with the undiagnosed status of participants with T2D. Compared with those in the hospital-based care setting, higher odds of not being diagnosed were observed in the coexistence of care setting (AOR 1.9, 95% CI 1.1-3.3; *P*=.03), community-based care setting (AOR 1.9, 95% CI 1.1-3.3; *P*=.02), and health center–based care setting (AOR 2.1, 95% CI 1.2-3.6; *P*=.01).

It was observed that among the 309 participants diagnosed with T2D, 177 (57.3%) were diagnosed by a private provider, 121 (39.2%) by a public provider, and 11 (3.6%) by others. Table 5 compares public providers with private providers in each setting in terms of the proportion of participants with diagnosed T2D status and that of those with T2D control status. No statistical significance was observed.

Table 4. Factors associated with the undiagnosed status of participants with type 2 diabetes in 2020 in Cambodia.

Characteristics	Adjusted odds ratio (95% CI)	*P* value
Age (years)		
40-49	3.2 (1.9-5.5)	*<.001*[a]
50-59	1.2 (0.8-1.8)	.34
≥60	Reference	N/A[b]
Sex		
Male	1.7 (1.1-2.5)	*<.001*
Female	Reference	N/A
Household wealth quintile		
1 (poorest)	2.3 (1.3-4.2)	*.005*
2	1.5 (0.9-2.6)	.14
3	1.1 (0.6-1.8)	.84
4	1.0 (0.6-1.8)	.92
5 (richest)	Reference	N/A
Care initiative setting		
Coexistence of care	1.9 (1.1-3.3)	*.03*
Community-based care	1.9 (1.1-3.3)	*.02*
Health center–based care	2.1 (1.2-3.6)	*.01*
Health center–based care with context	1.2 (0.7-2.0)	.60

Hospital-based care	Reference	N/A

[a]Italicization indicates values that met the significance threshold (*P*<.05).

[b]N/A: not applicable.

Table 5. Distributions of participants with diagnosed type 2 diabetes (T2D) status and those with T2D control status categorized by health care provider in each setting.

Setting	Public provider, n (%)	Private provider, n (%)	*P* value
Participants with diagnosed T2D status (N=298[a])			.10
Coexistence of care	26 (8.7)	22 (7.4)	
Community-based care	16 (5.4)	41 (13.8)	
Health center–based care	22 (7.4)	37 (12.4)	
Health center–based care with context	27 (9.1)	35 (11.7)	
Hospital-based care	30 (10.1)	42 (14)	
Participants with T2D control status			
Coexistence of care (N=38)			.57
HbA_{1c}[b] level <8%	3 (7.9)	3 (7.9)	
HbA_{1c} level ≥8%	12 (31.6)	20 (52.6)	
Community-based care (N=53)			.88
HbA_{1c} level <8%	3 (5.7)	3 (5.7)	
HbA_{1c} level ≥8%	25 (47.1)	22 (41.5)	
Health center–based care (N=55)			.20
HbA_{1c} level <8%	1 (1.8)	10 (18.2)	
HbA_{1c} level ≥8%	12 (21.8)	32 (58.2)	
Health center–based care with context (N=57)			.23
HbA_{1c} level <8%	8 (14)	7 (12.3)	
HbA_{1c} level ≥8%	15 (26.3)	27 (47.4)	
Hospital-based care (N=67)			.19
HbA_{1c} level <8%	11 (16.4)	11 (16.4)	
HbA_{1c} level ≥8%	15 (22.4)	30 (44.8)	

[a]The category of *other provider* was removed from the analysis owing to its small proportion, which made the statistical test unreliable.

[b]HbA_{1c}: glycated hemoglobin.

Discussion

Principal Findings

This study used primary data from a cross-sectional survey to generate the cascade of care for the T2D care continuum in 5 purposively selected ODs in Cambodia. Overall, the cascade displayed substantial drops at the testing stage (207/560, 37%, loss from the *prevalence* bar) and at the control stage (213/560, 38%, loss from the *in treatment* bar), indicating that all selected settings, regardless of the care initiatives present, have limited capacity to detect people with T2D and control the condition (blood glucose level control) in those with T2D despite being in receipt of treatment. The findings were consistent with the T2D cascade analyses in other LMICs that displayed significant losses at the testing stage (also 37%) [18]. However, the drop between the treatment stage and the control stage observed in this study was much larger than that in the studies in other LMICs—only 15% in other LMICs compared with 38% (213/560) in this study [18]. With the cutoff point of HbA1c level <8%, the proportion of those with T2D under control was 23% in other LMICs [18]; in this study, 10.7% (60/560) were considered as having achieved blood glucose level control. This is an exceptionally low rate, indicating that T2D in Cambodia is not being treated properly and adequately.

We disaggregated the cascades of care by study setting to observe the influence of the care initiatives. Unexpectedly, the coexistence of care setting displayed the worst cascade across all bars, whereas the hospital-based care setting had the best cascade among the 5 settings. This discovery was unexpectedly contradictory to the ICCC theoretical framework [3], calling into question the assumption underlying the ICCC framework that the combined care initiatives of health care organization and community represent an ideal context for integrated care for T2D and thereby would reduce leakages in the cascade. This suggests that the presence of health care infrastructure is not directly translated into improved care performance [29]. Implementation fidelity that focuses on the process of care implementation has to be taken into account [30]. Working mechanisms such as integrated care management across care levels and actors, the use of shared disease registries, and coordinated resources for self-management support and community education have to be in place for the coexistence of care to represent the ideal ICCC framework [3,16]. An investigation of the actual implementation of the care initiatives in these ODs was conducted in another study (Te V et al, unpublished data, July 2022). The investigation found that the 3 care initiatives were not implemented in an integrated way as intended in the written guideline [11] but in isolation, with limited interaction among them. The working mechanisms that facilitate integrated care for T2D in terms of shared necessary information and coordinated resources [16] were not observed. There was no proper system for following up patients for the continuity of care. The referral system among the communities, health centers, and referral hospitals was dysfunctional. The peer educator network in the OD with coexistence of care was not functioning optimally. The network had been handed over to the OD health authorities for governance, and technical or financial support from MoPoTsyo disappeared, rendering the network dysfunctional.

It should be noted that the care initiatives were not solely responsible for the provision of care for T2D in the selected ODs. On the basis of the same survey data, we found that, in general, health care use occurred dominantly in the private sector (78% among those seeking care in the 3 months preceding the survey), and referral hospitals were the common public health care facilities used by those with T2D and hypertension [31]. Therefore, our findings may not be fully attributed to the care initiatives. In the community-based care setting of OD Kong Pisey, only 12% (7/58) of the study participants were people living with T2D who were connected to the peer educator network, and only 4% (2/51) were connected to the peer educator network in the coexistence of care setting of OD Daunkeo. This may potentially undermine the effectiveness of community-based care. In a study based on MoPoTyso's routine data, 43% of the people in the network achieved the median HbA1c level of 7.1% [32]. In the hospital-based care setting of OD Samrong, only 5% (4/78) of the participants were seeking T2D care or treatment at the NCD clinic of the referral hospital in the 3 months preceding the survey, whereas at WHO PEN health centers in the health center–based care setting of OD Pearaing with high WHO PEN coverage, 3% (2/60) of the participants were identified seeking care for T2D.

Further statistical analysis, although not statistically significant, found that in all settings, except for the coexistence of care, private providers—who could not be fully incorporated into our study design owing to a lack of trustworthy information system in this sector—played a dominant role in diagnosing people with T2D. This suggests that the coexistence of care would increase the role of public health providers in the care continuum. In another study based on the same survey data, we found that the proportion of people with T2D seeking care at public health care facilities was higher than that of those with only hypertension or no condition [31]. This increased use of public health care facilities was also associated with a reduction in health care expenditure among patients, especially those in the poorest category of the wealth quintile who benefit from Health Equity Fund membership [31]. In a health system–level study, financial constraints have been found to be one of the main barriers to the T2D care continuum [6].

In this study, we found that 11.04% (560/5072) of the participants aged ≥40 years were identified as having T2D—of whom almost half (251/560, 44.8%) had not been diagnosed. This is a high prevalence rate because the overall prevalence rate of undiagnosed T2D in other LMICs has been reported to be 4.8% [18]. Predictors of being undiagnosed were being aged 40 to 49 years, being male, or falling in the poorest category of the wealth quintile. This suggests that more testing efforts are needed from the health system to reach people at risk for T2D, especially those from the aforementioned groups. A systematic review found that targeted screening was more cost-effective than universal screening [33]. A more convenient implementation arrangement for immediate diagnosis after testing should be put in place so that avoidable loss between these stages can be further minimized. In the national standard operating procedure [11], the WHO PEN health center staff are only allowed to perform the screening, whereas the diagnosis needs to be confirmed by the physician at the NCD clinic of the referral hospital. If the people who have been screened cannot have access to the diagnosis procedure at the referral hospital for some reason, the chances of not receiving prompt care or treatment increase. This requires strong

coordination between the health centers and the NCD clinics, which has to be robust and supportive.

Limitations

First, despite using the primary data collected intentionally for the construction of the cascades of care, the sample size was not large enough to yield a sufficiently large number of patients with T2D who had achieved T2D control to enable us to assess the determinants of this particular bar. Second, the care initiatives, either individually or in coexistence, were not exclusively responsible for the provision of T2D care in each OD, thereby resulting in a weak connection between the presence of care initiatives and the cascade of care results of each study setting. We used the OD as a proxy variable to measure the effect of the care initiative, which in fact could mask a number of potential confounding contextual factors such as the dominant use of private services. In addition, in the Cambodian health system, the population is not confined to a particular public health facility in the catchment area. People can shop around freely, which means that patients may use services outside the catchment area of the facility. Third, the cross-sectional design did not allow us to determine the causal pathways leading to diabetes care outcomes, and the use of self-reported data in related sections could have produced biased results. A longitudinal study design with the collection of routine cohort data would enable us to address the limitations and evaluate the effectiveness of the different T2D care initiatives over time. This can be supported by digital health interventions. Systematic reviews have demonstrated the effectiveness of telemedicine via smartphone functions to provide self-care education, facilitate self-monitoring, produce the required treatment reminders, and collect feedback for health care professionals, which facilitates informed treatment recommendations [34,35]. In Cambodia, a study assessing the potential use of a wearable health monitor in the prevention and control of NCDs revealed that this health technology had the potential to support activities related to health promotion, patient follow-up and monitoring, and surveys of NCD risk factors, with positive user experiences and high levels of acceptance [36,37]. A digital health intervention that was tried among the MoPoTsyo networks produced valuable knowledge on pathways to address barriers to successful adoption in the Cambodian context [38].

Conclusions

This study provided an updated estimate of T2D prevalence among people aged ≥40 years (approximately 1 in 10 people) in Cambodia. The findings revealed that the unmet need for T2D care was large, particularly in the testing and control stages, indicating the need to substantially improve early detection and management of T2D in Cambodia. With almost half of the study participants with T2D undiagnosed (251/560, 44.8%) and thus unaware of their condition, early detection of people with T2D is an important first step that the health system needs to achieve to improve the T2D care continuum. We recommend rapid scale-up of T2D care components at public health facilities to increase the chances of the population with T2D of being tested, diagnosed, retained in care, and treated, as well as of achieving blood glucose control. At the

same time, raising awareness and encouraging testing among the population at risk through a broad public health campaign should be one of the priorities. With advanced technology, a social media campaign has the potential to reach large parts of the population at low cost. Public health care use can reduce financial constraints among the population, particularly among those in the poorest category of the wealth quintile. We also recommend that within the context of resource constraints, specific groups considered susceptible (being male, being aged 40-49 years, or falling in the poorest category of the wealth quintile) should be especially targeted for testing through active community outreach activities because these groups are more likely to be unaware of their T2D condition. Adding care during off-hours for chronic conditions, including T2D, at public health facilities could increase access to care for male patients who are employed or busy during working hours. Future research should focus on evaluating the effectiveness of the different T2D care initiatives longitudinally with more diverse population groups from various settings. Given that digital health interventions have the potential to improve the prevention and control of NCDs while, at the same time, collecting longitudinal routine data vital for integrated care, feasibility and effectiveness studies of digital health interventions, such as telemedicine and mobile health, should be prioritized as a promising means to enable improvements along the T2D care continuum in Cambodia.

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Data Availability

The data sets generated and analyzed during this study are available from the corresponding author on reasonable request.

Authors' Contributions

All authors took part in conceptualizing the study design. VT and SC prepared the original draft. PI, JVO, VB, WVD, and EW provided feedback on the drafts. All authors read and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Cascade of care for type 2 diabetes (T2D) in 2020 in Cambodia. HbA1c: glycated hemoglobin.
[PNG File , 71 KB-Multimedia Appendix 1]

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Abbreviations

AOR: adjusted odds ratio
FBG: fasting blood glucose
HbA1c: glycated hemoglobin
ICCC: innovative care for chronic conditions
LMICs: low- and middle-income countries
NCD: noncommunicable disease
NECHR: National Ethics Committee for Health Research in Cambodia
OD: operational district
SCUBY: Scale-up Integrated Care for Diabetes and Hypertension
T2D: type 2 diabetes
WHO PEN: World Health Organization package of essential noncommunicable disease interventions
WHO: World Health Organization

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Chapter 6: Healthcare usage and expenditure among people with type 2 diabetes and/ or hypertension in Cambodia: results from a cross-sectional survey

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Abstract

Objective: To assess usage of public and private healthcare, related healthcare expenditure, and associated factors for people with type 2 diabetes (T2D) and/or hypertension (HTN) and for people without those conditions in Cambodia.

Methods: A cross-sectional household survey.

Settings: Five operational districts (ODs) in Cambodia.

Participants: Data were from 2360 participants aged ≥40 years who had used healthcare services at least once in the 3 months preceding the survey.

Primary and secondary outcome: The main variables of interest were the number of healthcare visits and healthcare expenditure in the last 3 months.

Results: The majority of healthcare visits took place in the private sector. Only 22.0% of healthcare visits took place in public healthcare facilities: 21.7% in people with HTN, 37.2% in people with T2D, 34.7% in people with T2D plus HTN and 18.9% in people without the two conditions (p value <0.01). For people with T2D and/or HTN, increased public healthcare use was significantly associated with Health Equity Fund (HEF) membership and living in ODs with community-based care. Furthermore, significant healthcare expenditure reduction was associated with HEF membership and using public healthcare facilities in these populations.

Conclusions: Overall public healthcare usage was relatively low; however, it was higher in people with chronic conditions. HEF membership and community-based care contributed to higher public healthcare usage among people with chronic conditions. Using public healthcare services, regardless of HEF status reduced healthcare expenditure, but the reduction in spending was more noticeable in people with HEF membership. To protect people with T2D and/or HTN from financial risk and move towards the direction of universal health coverage, the public healthcare system should further improve care quality and expand social health protection. Future research should link healthcare use and expenditure across different healthcare models to actual treatment outcomes to denote areas for further investment.

Strengths and limitations of the study

⇒ Our study is among the few to examine healthcare usage and expenditure among people with type 2 diabetes (T2D) and/or hypertension (HTN) in comparison to people without these two conditions in Cambodia.

⇒ The sampling design—randomising villages, households and household members—is robust within its scope, targeting the population in rural or semi-rural settings in Cambodia.

⇒ The data collection is robust and ensures a reliable dataset.

⇒The fact that the five operational districts were selected purposively limited the generalisability for the national level as most of the study sites we selected were rural or semi-rural.

⇒ The sample size for the group of people with T2D only and people with T2D plus HTN may be relatively small and may have insufficient power to assess the association between outcome variables and the dependent variables.

Introduction

Type 2 diabetes (T2D) and hypertension (HTN) are global public health concerns. They are major risk factors for cardiovascular diseases, causing about 31% (17.9 million) of all deaths worldwide annually.[1] The prevalence of people with T2D and/or HTN will likely continue to increase.[2 3] These two diseases disproportionately affect low-income and middle-income countries and account for around 75% of all deaths in these countries.[1]

In Cambodia, large scale population-based studies such as STEPS Surveys have shed light on the prevalence and risk factors of chronic diseases. The prevalence of T2D and HTN rose noticeably over recent years from 2.9% and 11.2% in the population aged 25–64 years in 2010 to 9.6% and 14.2% in the population aged 18–69 years in 2016, respectively. [4]

Previous nationally representative surveys have shown that a majority of the population seeks outpatient curative care in private facilities, but knowledge on the related healthcare uptake and expenditure among those with T2D and/or HTN is scarce.[5] Additionally, these surveys do not cover topics related to the management of the diseases, such as healthcare usage and expenditure.[6] There is only one study, by Bigdeli et al, which examines access to care for people with T2D and/or HTN concerning social health protection schemes in Cambodia.[7] This study shows that 61% of the people with T2D and/or HTN who knew their status were diagnosed in private facilities.[7] However, this study collected data in 2013, before key interventions were introduced or expanded in public healthcare facilities.[8] Also, it provides limited information about which types of health facilities were used, and what differences exist between people with one or both conditions compared with those without.

In the last decade, the Cambodian Ministry of Health (MoH), in collaboration with development partners, made significant efforts to improve the quality of public healthcare and initiated a few healthcare delivery models for people with T2D and/or HTN in public facilities.[8] These models include hospital-based care, health centre-based care, community-based care and a combination of all three models (coexisting care) (box 1). These efforts might have changed the pattern of healthcare usage and related expenditure, especially among people with T2D and/or HTN.

A better understanding of the current patterns of healthcare usage and expenditure among people with T2D and/or HTN is critical for better resource allocations and strategies to improve the management of T2D and HTN. The main objectives of this study are twofold. First, it evaluates usage and determines the factors associated with public healthcare use in four groups: (1) people without T2D or HTN, (2) people with T2D alone, (3) people with HTN alone and (4) people with T2D plus HTN. Second, it assesses the healthcare expenditure in the 3 months preceding the survey for all services used by the four patient groups in public and private facilities and determines factors associated with (reducing or increasing) healthcare expenditure.

Box 1 Overview of different care models in Cambodia in 2021

⇒ The hospital-based care model is standard care, which means an operational district (OD) has a government-run-noncommunicable disease clinic at the district referral hospitals.[8] By 2021, 31 out of 117 referral hospitals had implemented this model. The patients refer themselves to the units (and they are thus not transferred by an intermediary unit).

⇒ The health centre-based care model adopts the WHO Package of Essential Noncommunicable Disease Interventions (WHO PEN).[8] In this model, the Ministry of Health added the function of a health centre to hospital-based care. However, the coverage of health centres with the WHO PEN varies in each OD, which can be divided into low coverage (<50% of all health centres implement the WHO PEN; health centre-based care (low)) and high coverage (≥50% of all health centres implement the WHO PEN; health centre-based care (high)). The referral flow is slightly different between T2D and HTN. For T2D, this model identifies cases in the health centres through a screening test. If the patients are suspected of having T2D, health centres refer them to a diabetes clinic at a district referral hospital for confirmation of diagnosis. Once diagnosed, severe cases are treated in the hospital clinic, and stable or mild cases are followed up regularly at the health centres. For HTN, the health centres treat mild patients and refer the severe cases to the referral hospital. By 2021, health centre-based care was implemented in 137 of 1221 health centres.

⇒ The community-based care model or peer education network established and run by MoPoTsyo, a local non-governmental organisation.[8] In this model, peer educators (PEs) are added to hospital-based care. MoPoTsyo trained people with T2D and/or HTN to be PEs. These PEs play a role in screening and referring those suspected of having T2D and/or HTN to seek medical consultation and treatment at the referral hospitals that MoPoTsyo has partnered with. The PEs also provide counselling on lifestyle changes and support self-management to registered network members. By 2019, this community-based care model had been implemented in 20 of 102 ODs in 8 of 25 provinces in Cambodia.[8 32] It had 225 PEs to serve 40 000 people with T2D.[32]

⇒ The coexisting care model comprises a combination of the above three models. At the time of the study until 2021, only one OD (Daunkeo) had this model.

HTN, hypertension; T2D, type 2 diabetes.

Context

The health system in Cambodia is pluralistic, meaning healthcare services are provided by both public and private healthcare providers.[5 9] Public healthcare services in Cambodia dominate preventive services (reproductive, maternal, neonatal and child health), control of primary disease (tuberculosis, malaria and HIV/AIDS control) and inpatient treatment.[5] The facilities include health posts, health centres, district referral hospitals, provincial referral hospitals and national hospitals.[5] Public healthcare is organised per operational district (OD)—the third and last administrative level in Cambodia's health system management.[5] An OD covers a population of 100 000–200 000 people while a health centre covers a population of 10 000–20 000 people.[5] Remote areas with a small population can be covered by a health post.[5] The health post provides similar services to a health centre, but it is smaller than a health centre.[5] Each OD usually has one district referral hospital with a few ODs having two district hospitals.[5] The district referral hospital receives self-referred patients or those referred by the health centres.

Alongside this public sector, a large private healthcare sector exists, which is more accessible than the public sector, and dominates outpatient curative care.[5] Since 1994, the Cambodian government started economic liberalisation, permitting staff to work outside their government's working hours and own healthcare facilities.[5] Since then, the private healthcare sector and dual practice system, meaning public healthcare workers also have private practices, have grown rapidly. In 2015, over 50% of the healthcare workforce in private healthcare facilities were government personnel.[5] The private healthcare facilities range from cabinets, laboratories, pharmacies, clinics and polyclinics to hospitals.[5] Cabinets are the smallest facilities with less than two beds and mainly provide medical consultation services.[10 11] According to the MoH Progress Report in 2018, over 90% of private healthcare facilities were cabinets.[10 11] The second most frequent facilities were clinics (3.2%), providing medical specialties, laboratories, radiology services and pharmacies.[10] A clinic has between 10 and 20 beds.[10] In addition, buying medication in pharmacies or drugstores for self-treatment without a doctor's prescription is common in Cambodia, although not permitted by law.[12]

In terms of health expenditure, the public healthcare sector did not charge user fees until 1996.[5] In that year, the government introduced a user-fee scheme for the public sector with fees approved by the local community to increase healthcare quality at public healthcare facilities.[5 13] The revenue from the user fee scheme could be used to incentivise staff and support ongoing operations. However, the user fee posed challenges for the poor to access public healthcare. To address this, the MoH established the Health Equity Fund (HEF) in 2000, a pro-poor social health protection scheme.[14] The HEF is linked to the implementation of identification of the poor (known as 'ID Poor').[15] It is intended for the 'extremely poor' or 'poor' category, which is assessed and verified by the local authorities.[15] People with ID Poor are entitled to HEF support, meaning that they receive free healthcare services at public healthcare facilities and transportation expenditure reimbursement.[15] By 2019, the HEF covered approximately 3 million or about 20%

of Cambodia's population.[14] Another scheme is the National Social Security Fund (NSSF), established in 2007.[16] The NSSF covers work and non-work-related illnesses and injuries for formally employed people.[16] Formal employers are mandated to pay for their staff's NSSF membership. The NSSF had enrolled over 1.7 million employees or about 11% of the population by 2019.[17]

However, it is important to note that several studies have indicated that the private sector still constitutes a significant source for out-of-pocket expenditure (OOPE).[18 19] Between 2009 and 2016, around 60% of health expenditure was OOPE while the rest was a combination of the government's and development partners' budgets. The OOPE per capita increased slightly from US$40.6 in 2009 to US$48.1 in 2016.[19] In 2016, 76.6% of the total OOPE was linked to private healthcare.[18 19]

Methods

Data sources

This study is part of a larger cross-sectional household survey, with the primary aim of developing a care cascade for T2D and HTN.

Settings

The study purposively selected five ODs. The selection was made to include different T2D and/or HTN care models piloted in Cambodia: coexisting care, community-based care, health-centre based care (high), health-centre based care (low), and hospital-based care (box 1).

The five ODs in which the study took place are out of 103 ODs in the country and located in five different provinces. The map of ODs is presented in online supplemental annexure 1. These ODs have similar road infrastructure improvements, in which poor road conditions are no longer a barrier to accessing healthcare.

- OD Daunkeo, Takeo province: This OD had the 'coexisting care' model. At the time of the study, it was the only OD in which the three care models coexisted. The catchment area included Takeo town and a large rural area. Its non-communicable disease (NCD) clinic was established in 2002, and the peer educator network was initiated in 2007 and handed over to the MoH in 2015.[20] The WHO Package of Essential Noncommunicable Disease Interventions (PEN) was implemented in 5 out of 14 health centres since 2015. The private services for people with T2D and/or HTN may also be easily accessible.

- OD Kong Pisey, Kampong Speu province: This OD had the 'community-based care'

model. It has a strong MoPoTsyo network to provide T2D and HTN care to patients. Located about 54 km from the capital of Phnom Penh, this OD is semi-urban with a variety of private facilities.

- OD Pearaing, Prey Veng province: This OD had the 'health centre-based (high)' model, and was the OD with high coverage of the WHO PEN. Six out of nine health centres in this OD have been piloting the WHO PEN since 2015. Due to dual practice, the high coverage of the WHO PEN also facilitates accessible private services for people with T2D and/or HTN.

- OD Sot Nikum, Siem Reap province: This OD had the 'health centre-based (low)' model, and was the OD with low coverage of the WHO PEN (6/25 of the health centres started the WHO PEN in 2018). This OD has been historically and significantly influenced by the financial support of various development partners, and services for people with T2D and/or HTN have been well arranged at its NCD clinic.[21]

- OD Samrong, Oddar Meanchey province: This OD had a 'hospital-based care' model. It had an NCD clinic without the WHO PEN and peer educator network. A large part of the catchment area is a remote area bordering Thailand, approximately 470 km from the capital. Therefore, the private services for people with T2D and/or HTN may not be broadly accessible.

Samples

The larger household survey recruited 5072 individuals aged 40 years or older to participate in the study using a multistage cluster sampling method. Initially, it purposively chose five ODs with different care models for T2D and HTN. Second, 44 villages per OD were randomly selected, regardless of the population size of each OD. The purpose of this equal probability selection was to over-sample participants in ODs with a smaller population so that they would have an adequate sample for each care model. Third, 24 households in each village were selected by probability systematic sampling, and finally, one person aged 40 years or older per household was selected at random. To minimise the non-response rate, which can unintentionally exclude a certain group of the target population from the survey, the selected participants were called back or followed up three times when they were absent from their household. If the attempt failed, another household in the next row in the sampling list was selected. Then, the procedure described above was repeated. The equal probability selection at the village and household levels were used with the OD level's same purpose.

To correspond to our analytical objective, we used a subset of this sample: we only retained those who reported using healthcare services at least once in the 3 months preceding the survey (figure 1). A total of 2360/5072 participants met this criterion. The 2360 participant sample subset

included four patient groups: 1331 people without T2D and HTN, 761 people with HTN alone, 109 people with T2D alone and 159 people with T2D plus HTN.

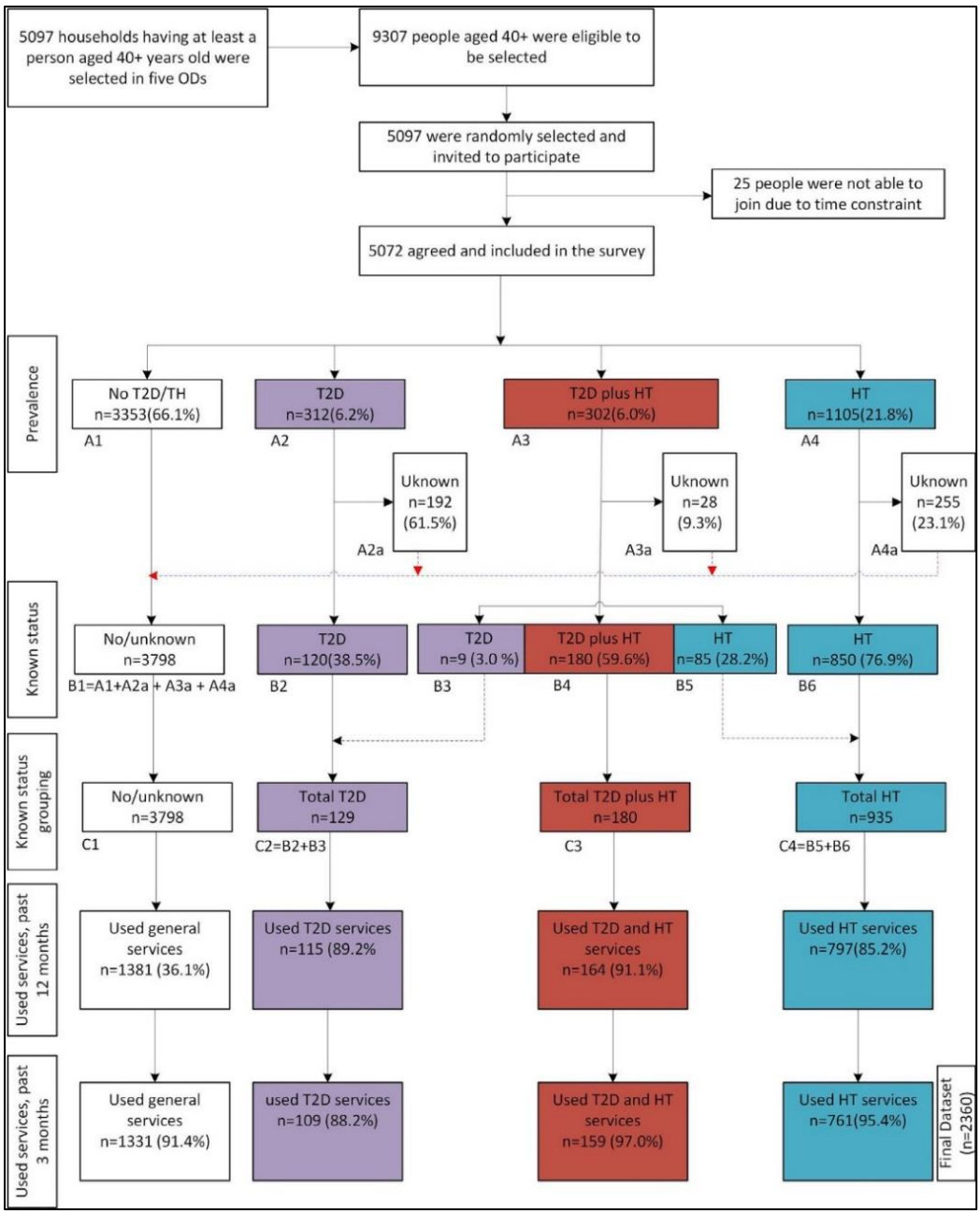

Figure 1 Data flow from household selection to final dataset in this study, Cambodia, 2020. HT, hypertension; ODs, operational districts; T2D, type 2 diabetes.

Data collection

The data collection took place between July and October 2020. The data collection was conducted in three steps following the WHO's STEPS Survey approach: (1) interviews with a structured questionnaire, (2) anthropometric measurements and (3) biochemical measurements.[6] Since our study only focuses on healthcare usage and expenditure, we only used information from step 1—interviews with a structured questionnaire.

The questionnaire was tablet-based and comprised 11 sections, including sociodemographic information, health status and quality of life, healthcare usage, social support, lifestyle or behaviour measures, physical activity, diabetes and hypertension knowledge, medication adherence, self-management support and decision-making power on food. However, we only used two sections in our analysis: sociodemographic information and healthcare usage.

The tablet-based questionnaire was installed using the Kobo Toolbox (https://kf.kobotoolbox.org), an open- source software with a free-of-charge server and online storage.[22]

Measures

This study's primary variable of interest is the number of visits to public and private facilities. By public healthcare facilities, we refer to government-run facilities that provide medical services, and include national hospitals, provincial referral hospitals, district referral hospitals, health centres and health posts. A health post is similar to a health centre, and only a few exist in remote areas. Therefore, we grouped them with health centres. Private healthcare services are non-government organisations that provide medical and non-medical services, and include private hospitals, private clinics, pharmacies, homes of trained health workers and visits of health workers to the patients' homes. Traditional healing/medicine and using healthcare services abroad have also been included in this category.

The secondary variable of interest was healthcare expenditure, the lump sum expenditure of medical consultation, treatment and medication. These data were obtained from the interview with the participants. They were asked about their use of health services in the 3 months preceding the survey (where they went, how often they went to a particular type of healthcare facility and how much they spent in each facility in those 3 months). We include the questionnaire in online supplemental annexure 2. The Cambodian currency (riels) was converted into US dollars (USD) at an exchange rate of 4000 riels per USD. The expenditure does not include other spending such as on transport, food or guesthouses/hotels.

To better understand the profile of people using public or private healthcare facilities, we estimated associations between the use of public and private healthcare services and patient

characteristics such as sex (male, female), age (40–49, 50–59, 60+ years old), educational level (none, primary, secondary or higher), social protection status (NSSF (yes, no), HEF (yes, no)), wealth quintile (poorest, poor, medium, rich, richest), type of care models (hospital-based, health centre-based (high), health centre-based (low) and community-based). The details on wealth quintile calculation (socioeconomic class) are described in online supplemental annexure 3.

Analysis

Healthcare usage

Taking the number of visits as a dependent variable, we report the healthcare visit rate to public and private facilities over the 3 months preceding the survey, then stratified by patient groups.

To identify the independent factors associated with healthcare usage (defined by the number of visits), we first used bivariate negative binomial regression to identify the potential factors in the five groups—overall and four patient groups—separately. Variables with a p-value <0.25 in at least one of the four patient groups or overall group were included in the multiple negative binomial regression. The exposure variable (total healthcare visits of each participant) was incorporated into this model. Variables with a p-value <0.05 were considered statistically significant in this final model. The negative binomial regression was chosen over Poisson regression because the number of visits was over-dispersed.

Healthcare expenditure

We took healthcare expenditure in the 3 months preceding the survey as the dependent variable. Due to the limitation of our data, we focused more on assessing the factors associated with healthcare expenditure and did not explore the overall medical expenditure. We reported the overall arithmetic mean and then stratified the mean by patient groups. The expenditure was calculated separately for each patient group. Because arithmetic means can be easily affected by extremely high values, we removed the values above the 90^{th} percentile, which we believe were too high in our sample.

Our analysis was carried out in three steps to separately identify the independent factors associated with healthcare expenditure in the four patient groups. First, a logarithmic transformation of the healthcare expenditure was performed as the data was skewed to the right. Second, in the bivariate analysis, we compared the geometric mean of healthcare expenditure by characteristics of the participants. This analysis identified the variables potentially associated with the healthcare expenditure at a p-value <0.25. During this phase, the Student's t-test for binary explanatory variables and the one-way analysis of variance test for non-binary explanatory variables were used. Variables with a significant level at a p-value <0.25 in any patient group were included in the multiple linear regression. Third, multiple linear regression

was performed and the coefficient and 95% CI values were exponentiated to a risk ratio (RR) for better interpretation. Data were analysed using Stata V.16.0 (Stata Corp LLC, College Station, Texas, USA), and R programing's GGPLOT2 package was used to produce the graphs.

Patient and public involvement

No patient was involved in the development of the research question and outcome measures, study design and study participant recruitment. The findings are not disseminated to the study participants.

Table 1 Demographic and socioeconomic characteristics of participants, 2020, Cambodia

Variable	Overall (N=2360)	No T2D/HTN (N=1331) n (%)	HTN (N=761) n (%)	T2D (N=109) n (%)	T2D plus HTN (N=159) n (%)	P value
Sex of participant						
Male	689 (29.2)	457 (34.3)	179 (23.5)	29 (26.6)	24 (15.1)	<0.001
Female	1671 (70.8)	874 (65.7)	582 (76.5)	80 (73.4)	135 (84.9)	
Age in years						
Range	40–96	40–96	40–90	40–81	40–82	
Mean (±SD)	58.5 (± 10.4)	56.0 (±10.3)	62.4 (±10.0)	57.6 (±8.4)	61.7 (±8.2)	<0.001
40–49	497 (21.1)	398 (29.9)	75 (9.9)	17 (15.6)	7 (4.4)	<0.001
50–59	803 (34.0)	464 (34.9)	231 (30.4)	46 (42.2)	62 (39.0)	
60 or older	1060 (44.9)	469 (35.2)	455 (59.8)	46 (42.2)	90 (56.6)	
Educational level						
No formal schooling	757 (32.1)	393 (29.5)	283 (37.2)	35 (32.1)	46 (28.9)	<0.016
Primary school	1308 (55.4)	755 (56.7)	398 (52.3)	61 (56.0)	94 (59.1)	
Secondary school or higher	295 (12.5)	183 (13.7)	80 (10.5)	13 (11.9)	19 (11.9)	
Having NSSF membership (yes)	114 (4.8)	62 (4.7)	36 (4.7)	6 (5.5)	10 (6.3)	0.806
Having HEF membership (yes)	434 (18.4)	247 (18.6)	143 (18.8)	18 (16.5)	26 (16.4)	0.849
Wealth quintile						
Poorest	441 (18.7)	261 (19.6)	140 (18.4)	16 (14.7)	24 (15.1)	0.050
Poor	447 (18.9)	263 (19.8)	139 (18.3)	18 (16.5)	27 (17.0)	
Medium	467 (19.8)	262 (19.7)	144 (18.9)	27 (24.8)	34 (21.4)	
Rich	480 (20.3)	244 (18.3)	176 (23.1)	16 (14.7)	44 (27.7)	
Richest	525 (22.2)	301 (22.6)	162 (21.3)	32 (29.4)	30 (18.9)	
Care model						
Coexisting	432 (18.3)	248 (18.6)	147 (19.3)	20 (18.3)	17 (10.7)	0.015
Community-based	480 (20.3)	276 (20.7)	153 (20.1)	18 (16.5)	33 (20.8)	
Health centre-based (high)	486 (20.6)	257 (19.3)	174 (22.9)	27 (24.8)	28 (17.6)	
Health centre-based (low)	518 (22.0)	292 (21.9)	170 (22.3)	18 (16.5)	38 (23.9)	
Hospital-based	444 (18.8)	258 (19.4)	117 (15.4)	26 (23.9)	43 (27.0)	

Health centre-based (high) means the operational district (OD) with high coverage (six out of nine) of health centres with the WHO Package of Essential Non-communicable Disease Interventions (PEN); health centre-based (low) means the OD with low coverage (6 out of 25) of health centres with the WHO PEN.
HEF, Health Equity Fund; HTN, hypertension; NSSF, National Social Security Fund; T2D, type 2 diabetes.

Results

Characteristics of participants

Our analysis included 2360 participants, including 1331 people without T2D or HTN, 761 people with HTN alone, 109 with T2D alone and 159 with T2D plus HTN (table 1). The other participants were excluded because they had not used healthcare services in the 3 months preceding the survey (N=2703) or had a missing response to the primary variable of interest (N=9).

As shown in table 1, females were more prevalent in all patient groups, especially in the T2D plus HTN group. The age range was between 40 and 96 years, with people with HTN and T2D plus HTN having a significantly higher average age than those without the two conditions. The majority of participants did not attend school or attended only primary school.

Regarding the social health protection scheme, a small proportion of participants in all groups had the NSSF membership (4.8% overall). A larger proportion of patients across all groups had the HEF membership (18.4% overall).

Public and private healthcare usage

The 2360 individuals reported 6645 visits to the healthcare facilities in the 3 months preceding the survey, averaging 2.8 visits per person over 3 months.

Figure 2 presents the proportion of visits to public and private healthcare facilities. At the facility level, as shown in figure 2A, the largest share was accounted for by private clinics (28.5%), followed by visits to the private homes of nurses or doctors (15.6%), private pharmacies (15.3%), health centres (12.6%), and private hospitals (11.6%).

The common public healthcare facilities used by participants with T2D and T2D plus HTN were provincial/national and district referral hospitals (figure 2A). Approximately 29.7% of visits from people with T2D and 29.6% from people with T2D plus HTN went to provincial/national and district hospitals (figure 2A). These proportions were higher than 6.9% for people without T2D or HTN and 6.1% for HTN only.

Overall, the private sector occupied about 78.0% of the total visits, and the public sector occupied 22.0% (figure 2B). All groups visited private healthcare facilities more frequently than public healthcare facilities (figure 2). However, the frequency of visiting public facilities was statistically higher in people with T2D and T2D plus HTN. As shown in figure 2B, 37.2% of visits from people with T2D and 34.7% of visits from people with T2D plus HTN were to public healthcare facilities,

compared with 18.9% of visits from people without the two conditions and 21.7% of the visits from people with HTN (p-value<0.001).

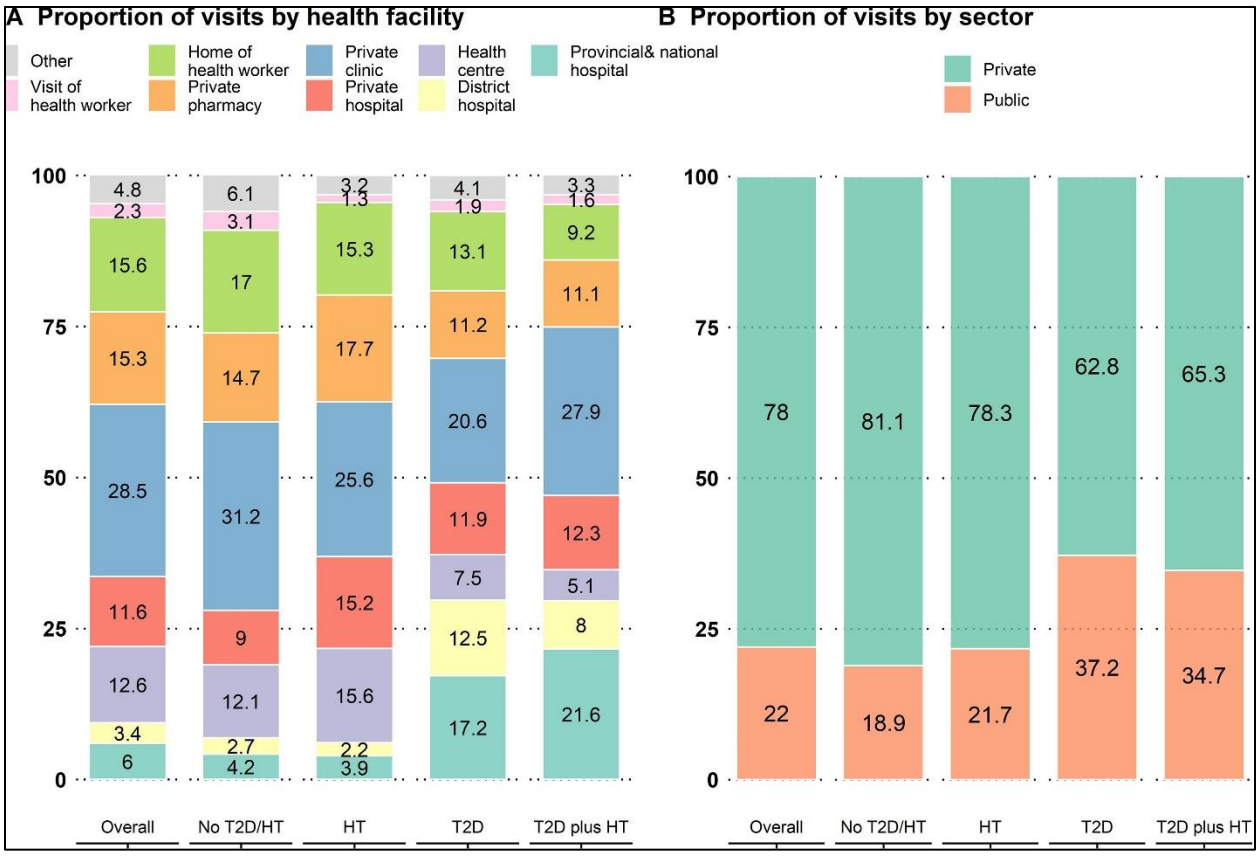

Figure 2 Proportion of visits to public and private facilities in Cambodia, 2020. HT, hypertension; T2D, type 2 diabetes.

Public healthcare usage by participant characteristics

Table 2 compares the public healthcare facility user rates defined as the proportion of public healthcare visits over total visits (public visits plus private visits). The user rates were disaggregated by participant characteristics. In this bivariate analysis, age, NSSF, HEF, wealth quintile and care model were significantly associated with public healthcare usage at a p-value <0.25 in at least one patient group. Therefore, we included these variables in the multiple negative binomial regressions.

Table 3 presents the results of the multiple negative binomial regressions. Overall, the significant increase in public healthcare use was associated with having T2D and T2D plus HTN, living in the OD with coexisting care, and HEF membership. In people without T2D or HTN, HEF membership was significantly associated with public healthcare use: adjusted incidence rate ratio (AIRR) of 1.4

(95% CI 1.0 to 2.0), p-value <0.05. We did not observe the same association in the other three groups.

In people with HTN, the poorest category was significantly associated with increasing public healthcare use with an AIRR of 2.1 (95% CI 1.1 to 4.0), p-value=0.02, compared with those in the richest category. Nevertheless, the same association was not seen in other patient groups.

Table 2 Proportions of visits to public facilities by participant characteristics, 2020, Cambodia

Variable	Overall (N=6645) User rate (%)	No T2D/HTN (N=3467) User rate (%)	HTN (N=2345) User rate (%)	T2D (N=320) User rate (%)	T2D plus HTN (N=513) User rate (%)
Sex					
Male	20.9	17.9	21.9	47.2	26.4
Female	23.7	20.7	23.2	33.3	37.6
P value	0.936	0.803	0.879	0.552	0.847
Age in years					
40–49	17.5	14.8	27.4	23.8	32.1
50–59	24.3	22.4	19.2	35	51.4
60+	24.0	21.1	24.2	43.5	26.3
P value	0.442	**0.096**	0.601	0.708	0.254
Educational level					
No schooling	21.9	20.1	19.3	37.5	39.6
Primary	22.9	18.8	23.2	45	34.6
Secondary/higher	25.5	22.6	33.1	__	29.5
P value	0.998	0.981	0.606	0.92	0.932
Having NSSF membership					
No	22.2	19.9	21.2	37.5	33.3
Yes	35.9	17.1	52.4	31.6	66.7
P value	0.512	0.4505	**0.165**	0.808	0.343
Having HEF membership					
No	19.8	18	18.3	34.2	29.5
Yes	35.7	27.5	39.5	55.6	65.1
P value	**<0.001**	**0.01**	**0.014**	0.346	**0.04**
Household socioeconomic class					
Poorest	28.2	20.4	33.5	54.5	58
Poor	24.9	23.5	23.3	27.3	42.7
Medium	22.3	15.2	25.7	36.6	37.5
Rich	22.1	20.5	19.9	50	30
Richest	18.1	18.9	14.8	29.9	16.5
P value	0.029	0.419	**0.083**	0.966	**0.218**
Care model					
Coexisting	31.1	25.8	36.6	53.0	20.0
Community-based	19.5	18.0	13.6	56.8	39.2
Health centre-based (high)	14.7	13.2	14.8	19.0	23.8
Health centre-based (low)	21.4	21.5	16.6	46.7	32.7
Hospital-based	24.4	16.3	29.7	22.5	42.9
P value	**0.002**	**0.007**	**0.018**	**0.172**	**0.162**

The percentage of private healthcare is not presented in this table but can it be calculated by subtracting the percentage of the public healthcare from 100%. Health centre-based (high) means the operational district (OD) with high coverage (six out of nine) of health centres with the WHO Package of Essential Non-communicable Disease Interventions (PEN); health centre-based (low) means the OD with low coverage (6 out of 25) of health centres with the WHO PEN. 'N' denotes the total of visits. P values <0.25 are in bold, indicating a significant level at 0.25. Variables with p value <0.25 were included in multivariate analysis.
HEF, Health Equity Fund; HTN, hypertension; NSSF, National Social Security Fund; T2D, type 2 diabetes.

Regarding the care model, in people with T2D, the OD with community-based care (AIRR 3.7 (95% CI 1.2 to 11.3), p-value=0.019) and the OD with low coverage of health centre-based care (AIRR 3.3 (95% CI 1.1 to 9.8), p-value=0.036) were significantly higher in public healthcare use than in the OD with hospital-based care.

In people with T2D plus HTN, the OD with coexisting care was associated with higher public healthcare use (AIRR 4.0 (95% CI 1.2 to 12.9), p-value=0.020).

Table 3 Factors associated with public healthcare use, 2020, Cambodia

	Overall (N=2360)	No T2D/HTN (N=1331)	HTN (N=161)	T2D (N=109)	T2D plus HTN (N=759)
Disease group	**AIRR (95% CI)**	**AIRR (95% CI)**	**AIRR (95% CI)**	**AIRR (95% CI)**	**AIRR (95% CI)**
No T2D/HTN	Ref.	–	–	–_	–
HTN	1.0 (0.8 to 1.2)	–	–	–	–
T2D	**1.9 (1.3 to 2.9)****	–	–	–	–
T2D plus HTN	**1.9 (1.3 to 2.7)*****	–	–	–	–
Age in year					
40–49	Ref.	Ref.	Ref.	Ref.	
50–59	1.2 (0.9 to 1.5)	1.4 (1.0 to 1.9)	0.6 (0.3 to 1.2)	1.5 (0.5 to 4.5)	1.2 (0.3 to 4.2)
60+	1.1 (0.8 to 1.4)	1.2 (0.9 to 1.7)	0.7 (0.4 to 1.3)	1.5 (0.5 to 4.5)	0.6 (0.2 to 2.2)
Having NSSF membership					
No	Ref.	Ref.	Ref.	Ref.	
Yes	1.4 (0.9 to 2.1)	1.0 (0.5 to 1.8)	2.0 (0.9 to 4.6)	2.3 (0.5 to 10.1)	1.9 (0.7 to 4.8)
Having HEF membership					
No		Ref.	Ref.	Ref.	
Yes	**1.4 (1.1 to 1.8)***	**1.4 (1.0 to 2.0)***	1.4 (0.9 to 2.3)	2.1 (0.8 to 5.1)	**1.9 (1.0 to 3.7)**
Household socioeconomic class					
Poorest	**1.4 (1.0 to 2.0)***	1.0 (0.7 to 1.6)	**2.1 (1.1 to 4.0)***	1.2 (0.4 to 3.5)	2.6 (0.9 to 7.1)
Poor	1.2 (0.9 to 1.7)	1.1 (0.7 to 1.7)	1.2 (0.7 to 2.3)	0.7 (0.2 to 2.1)	2.6 (1.0 to 7.3)
Medium	1.1 (0.8 to 1.5)	0.9 (0.6 to 1.4)	1.2 (0.7 to 2.3)	0.9 (0.4 to 2.2)	3.0 (1.2 to 7.7)
Rich	1.1 (0.8 to 1.4)	1.1 (0.7 to 1.7)	1.0 (0.6 to 1.8)	1.2 (0.4 to 3.5)	1.7 (0.7 to 4.1)
Richest	Ref.	Ref.	Ref.	Ref.	Ref.
Care model					
Coexisting	**1.4 (1.0 to 1.9)***	1.5 (1.0 to 2.3)	1.3 (0.7 to 2.3)	2.5 (0.8 to 7.6)	**4.0 (1.2 to 12.9)***
Community-based	0.9 (0.7 to 1.2)	1.0 (0.6 to 1.5)	0.5 (0.3 to 1.0)	**3.7 (1.2 to 11.3)***	1.7 (0.5 to 6.1)
Health centre-based (high)	0.8 (0.6 to 1.1)	0.8 (0.5 to 1.3)	0.7 (0.4 to 1.3)	1.3 (0.4 to 3.9)	2.7 (0.9 to 8.8)
Health centre-based (low)	1.0 (0.8 to 1.4)	1.4 (1.0 to 2.1)	0.6 (0.3 to 1.0)	**3.3 (1.1 to 9.8)***	3.0 (1.0 to 9.1)
Hospital-based	Ref.	Ref.	Ref.	Ref.	Ref.

Health centre-based (high) means the OD with high coverage (six out of nine) of health centres with the WHO Package of Essential Non-communicable Disease Interventions (PEN); health centre-based (low) means the OD with low coverage (6 out of 25) of health centres with the WHO PEN.
*p<0.05, **p<0.01, ***p<0.001.
AIRR, adjusted incidence rate ratio; HEF, Health Equity Fund; HTN, hypertension; NSSF, National Social Security Fund; OD, operational district; Ref., reference group; T2D, type 2 diabetes.

Healthcare expenditure

Medical cost per year, overall and by facility

Overall, those who used healthcare spent an average of US$25.3 (95% CI 22.9 to 27.6) for all healthcare services in the 3 months preceding the survey (figure 3).

When comparing patient groups, people with T2D plus HTN had the highest healthcare expenditure with an average of US$43.6 (95% CI 29.7 to 57.2), followed by people with T2D with an average of US$34.0 (95% CI 25.5 to 42.6). These expenditures were statistically higher than the average of US$17.1 (95% CI 13.1 to 21.1) in people with HTN and the average of US$26.9 (95% CI 23.9 to 29.9) in people without the two conditions with a p-value <0.001.

Online supplemental annexure 4 table S1 shows the arithmetic mean of healthcare expenditure. The arithmetic mean is the mean before the data log-transformation. Since our model's RR in table 4 is the geometric mean (after log-transformation) ratio, we presented the geometric mean in online supplemental annexure 4 table S2. In the bivariate analysis, sex, age, NSSF, HEF, wealth quintile, sector (public vs private) and care model were statistically associated with healthcare expenditure in one or more patient groups with a p-value <0.25. These variables were included in the multiple linear regression.

Table 4 presents results from the multiple linear regression analyses. Overall, having T2D or T2D plus HTN, being female, having reported using both private and public healthcare, and living in the OD with community-based care was significantly associated with increased healthcare expenditure. In contrast, holding HEF membership and using public healthcare was significantly associated with healthcare expenditure reduction.

At the group level, in people without the two conditions, HEF membership was significantly associated with a reduction in healthcare expenditure with an adjusted RR (ARR) of 0.7 (95% CI 0.5 to 0.8), p-value <0.001. The same association was seen in people with HTN (ARR of 0.8 (95% CI 0.6 to 1.0), p-value <0.01), and in T2D plus HTN (ARR of 0.3 (95% CI 0.2 to 0.6), p-value <0.001). However, the association was not observed in people with T2D.

In people without the two conditions, using public healthcare was significantly associated with a reduction in the expenditure (ARR of 0.3 (95% CI 0.2 to 0.3), p-value <0.001). The association was also found in people with HTN (ARR 0.4 (95% CI 0.3 to 0.5), p-value <0.001).

People with T2D plus HTN who resided in the OD with community-based care were significantly associated with a higher expenditure with an ARR of 2.0 (95% CI 1.1 to 3.8), p-value <0.01 than those with hospital-based care.

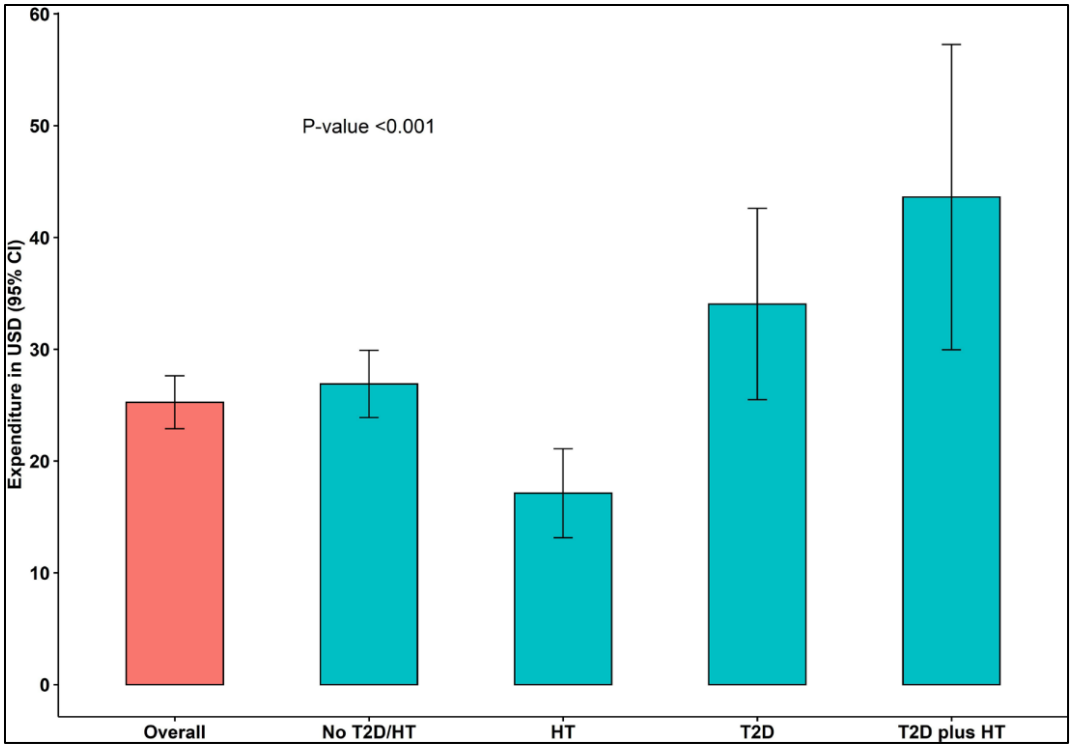

Figure 3 Healthcare expenditure by patient groups in the 3 months preceding the survey in 2020, Cambodia. HT, hypertension; T2D, type 2 diabetes.

Table 4 Factors associated with reducing or increasing healthcare expenditure in 2020, Cambodia

Variable	Overall (N=2142) ARR (95% CI)	No T2D/HTN (N=1187) ARR (95% CI)	HTN (N=726) ARR (95% CI)	T2D (N=98) ARR (95% CI)	T2D plus HTN (N=139) ARR (95% CI)
Disease group					
No T2D/HTN	Ref.	–	–	–	–
HTN	0.9 (0.7 to 1.0)	–	–	–	–
T2D	**2.1 (1.6 to 2.7)*** **	–	–	–	–
T2D plus HTN	**1.9 (1.5 to 2.4)*** **	–	–	–	–
Sex					
Male		Ref.	Ref.	Ref.	Ref.
Female	**1.2 (1.1 to 1.4)** **	**1.4 (1.2 to 1.7)*** **	1.0 (0.8 to 1.2)	0.7 (0.4 to 1.5)	1.5 (0.8 to 2.9)
Age in years					
40–49	Ref.	Ref.	Ref.	Ref.	
50–59	1.1 (0.9 to 1.3)	1.0 (0.8 to 1.2)	1.4 (1.0 to 2.0)	1.1 (0.5 to 2.4)	1.4 (0.5 to 3.7)
60+	1.0 (0.9 to 1.2)	1.1 (0.8 to 1.3)	1.3 (1.0 to 1.9)	0.9 (0.4 to 1.9)	1.0 (0.4 to 2.7)
Educational level					
No schooling	Ref.	Ref.	Ref.	Ref.	Ref.
Primary	1.0 (0.9 to 1.1)	1.1 (0.9 to 1.4)	0.8 (0.7 to 1.0)	0.9 (0.5 to 1.7)	1.1 (0.7 to 1.8)
Secondary/higher	1.1 (0.8 to 1.3)	1.2 (0.9 to 1.6)	0.9 (0.6 to 1.3)	–	1.6 (0.7 to 3.7)
Having NSSF membership					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	0.9 (0.6 to 1.2)	0.9 (0.6 to 1.4)	0.9 (0.6 to 1.4)	0.6 (0.2 to 2.0)	**0.4 (0.2 to 0.9)***
Having HEF membership					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	**0.7 (0.6 to 0.8)*** **	**0.7 (0.5 to 0.8)*** **	**0.8 (0.6 to 1.0)*** **	0.7 (0.3 to 1.6)	**0.3 (0.2 to 0.6)*** **
Household wealth quintile					
Poorest	1.1 (0.9 to 1.4)	1.3 (0.9 to 1.7)	1.1 (0.8 to 1.5)	0.5 (0.2 to 1.2)	1.1 (0.5 to 2.2)
Poor	1.1 (0.9 to 1.3)	1.1 (0.8 to 1.4)	1.2 (0.9 to 1.7)	0.8 (0.3 to 1.8)	0.6 (0.3 to 1.3)
Medium	1.1 (0.9 to 1.3)	1.1 (0.8 to 1.4)	1.2 (0.9 to 1.6)	0.8 (0.4 to 1.6)	0.9 (0.4 to 1.7)
Rich	1.2 (1.0 to 1.4)	1.3 (1.0 to 1.7)	1.2 (0.9 to 1.6)	0.7 (0.3 to 1.7)	0.9 (0.5 to 1.7)
Richest	Ref.	Ref.	Ref.	Ref.	Ref.
Healthcare sector					
Private	Ref.	Ref.	Ref.	Ref.	Ref.
Public	**0.3 (0.3 to 0.4)*** **	**0.3 (0.2 to 0.3)*** **	**0.4 (0.3 to 0.5)*** **	0.7 (0.4 to 1.2)	0.8 (0.5 to 1.3)
Both	**1.5 (1.1 to 1.9)*** **	**1.6 (1.1 to 2.4)** **	0.9 (0.4 to 1.7)	–	1.2 (0.3 to 5.4)
OD with different care					
Coexisting	1.0 (0.9 to 1.3)	1.0 (0.8 to 1.3)	1.0 (0.7 to 1.4)	1.0 (0.4 to 2.6)	1.7 (0.8 to 3.9)
Community-based	**1.4 (1.1 to 1.6)** **	1.2 (0.9 to 1.6)	1.3 (1.0 to 1.9)	1.3 (0.6 to 3.2)	**2.0 (1.1 to 3.8)** **
Health centre-based (high)	1.0 (0.8 to 1.2)	1.0 (0.7 to 1.3)	1.1 (0.8 to 1.5)	0.9 (0.4 to 1.9)	1.3 (0.7 to 2.6)
Health centre-based (low)	0.8 (0.7 to 1.0)	0.8 (0.6 to 1.0)	0.8 (0.6 to 1.1)	1.3 (0.5 to 3.0)	1.5 (0.8 to 2.6)
Hospital-based	Ref.	Ref.	Ref.	Ref.	Ref.

*p<0.05, **p<0.01, ***p<0.001.
Health centre-based (high) means the operational district (OD) with high coverage (six out of nine) of health centres with the WHO Package of Essential Non-communicable Disease Interventions (PEN); health centre-based (low) means the OD with low coverage (6 out of 25) of health centres with the WHO PEN; p values <0.05, <0.01, <0.001 are in bold, indicating the variables are significantly associated with expenditure.
ARR, adjusted risk ratio; HEF, Health Equity Fund; HTN, hypertension; NSSF, National Social Security Fund; OD, operational district; Ref., reference group; T2D, type 2 diabetes.

Discussion

The results show that the use of the public healthcare system remains low for all groups in our study, with about one in every five healthcare visits taking place in the public sector overall. People with chronic conditions, HEF membership, living in the OD with community-based care contributed to public healthcare uptake. The healthcare expenditure was significantly reduced when patients used public healthcare services, regardless of HEF membership. However, the reduction in spending was more noticeable in people with HEF membership. In contrast, expenditure was higher among patients living in the OD with community-based care.

People in Cambodia predominantly used healthcare in private facilities for outpatient curative care.[19] Our study showed that this is also the case for people with chronic conditions such as T2D and HTN, although this group had a slightly higher rate of using public healthcare services. This result is congruent with earlier findings that approximately 61% of T2D and/or HTN patients received their initial diagnosis in private settings.[7] A qualitative study in Cambodia suggested that people with T2D did not prefer diabetes services at public facilities because they were less accessible due to geographical factors or distance and limited medication supply.[23] Comparing our findings to other low-income and middle-income countries is challenging due to differences in health system organisation, government investment in health and most studies focusing on general services rather than T2D and/or HTN services. Nevertheless, our findings are comparable to those from India, Nigeria and Nepal, where government accounts for a very small share (<30%) of national health expenditure as well.[24] In India, 75% of outpatient visits were occupied by the private sector, similar to Nigeria (82%) and Nepal (65%).[24] Cambodia and these three countries shared similar characteristics as the majority of the population relies on low-cost, and low-quality private services. Our findings clearly suggest that healthcare quality and access to public healthcare services is still below the expectations of people and the private providers have a role in filling the gaps. To move forward in the direction of universal health coverage, meaning that people can access the health services they need without financial hardship, Cambodia should focus on expanding quality service coverage for people with T2D and/or HTN at public healthcare facilities across the country. Expanding quality services at public healthcare facilities may be the best suited approach to the Cambodian context, where dual practice is strong and regulation weak. The literature suggests that the public and private providers are not mutually exclusive and they shape each other's characteristics or sometimes so-called competition for health benefits.[24–27] If public healthcare providers can provide quality services at affordable prices to the poor or those from low-income households, visits to private healthcare providers, who offer inferior services at higher prices, will decrease.[24–27] The private healthcare providers will change their service provision to target the rich.[24–27] Previous studies revealed that HEF membership contributed to the health service uptake at public facilities and reduced healthcare expenditure in general users.[14 28] Our findings extended the under- standing that HEF membership has also increased public healthcare use and substantially reduced healthcare spending among people with T2D and/or HTN. Since HEF benefits are only available in public healthcare facilities, it is not

surprising that it also contributes to increasing service uptake in public facilities. The HEF is an important pillar of the Cambodian government's social security system and our findings suggest that HEF membership should be expanded to cover among people with chronic conditions. The Cambodian government recognised that the current social protection system has not yet covered those so-called 'missing middle' between the poor, who are covered by the HEF, and those in formal employment, who are covered by the NSSF. Therefore, a new social health protection scheme targeting those in the informal economy and senior population without pensions, which accounts for 90% of people aged 60 years or older in Cambodia, should be created. This social protection scheme must go alongside with improving service coverage and quality. The success of such a model has been demonstrated by Thailand, a neighbouring country of Cambodia.[29 30] Thailand focused on improving public healthcare services and introduced three public health insurance schemes. One of them was the Universal Coverage Scheme, which covered 75% of the Thai population.[29] Such a model might be too ambitious for Cambodia, since Thailand is more economically developed than Cambodia. However, this is still a model that Cambodia should be aiming for, so that quality health services for people with T2D and/or HTN will be more accessible.

Community-based care contributed to the higher public service uptake among T2D and/or HTN, but it also contributed to the higher expenditure for the users. In ODs with this model, peer educators (PEs) refer patients to the public referral hospitals, so it is not surprising that the public service uptake is slightly higher than other ODs.[31] However, it is somewhat surprising that people with T2D and/or HTN in the OD with community-based care spent more on their health services. It is unclear what the influencing factors are because a large proportion of service users (80%) used private services in this OD. Although, this may be partially explained by higher unit costs spent by the supply side in community-based care to operate their services, so the patients are charged a higher fee than other models. Our team had conducted a costing study in 2020 to examine the costs to operate services by different care models. The study found that the annual unit costs were higher for T2D and HTN patients in the community-based care than the hospital-based care (US$101 vs US$77 for a T2D patient and US$83 vs US$55 for an HTN patient). The higher unit costs in the community-based care were driven by adding PE components and field activities to the model while drugs and consultation fee are not subsidised. The investment in community-based care leads to better treatment outcomes, but it is not explored in our study. A previous study provided limited information that a significant proportion of patients in the community-based care network had achieved fasting blood glucose goals of 126 mg/dL, from 10% to 45%, and blood pressure goals of 140/90 mm Hg, from 58% to 67%, after a 12-month follow-up.[20] This study, however, did not have a control group (patients outside the network). From this, we can learn two things. First, the adapting and scaling up of PEs should be done with a careful budget plan as PEs incur operational costs. Second, a study investigating the treatment outcomes and cost-effectiveness between different care models should be conducted in order to inform decision-making. We, therefore, cannot make a recommendation from this limited finding.

There are several strengths in our study. First, our study is among the few to examine healthcare usage and expenditure both among people with T2D and/or HTN and people without the two conditions in Cambodia. It furthermore covers both the public and private sectors. This broad scope renders the results useful to inform T2D and HTN interventions in Cambodia. Second, we covered a wide range of ODs which are geographically diverse and comprising different care models, which means that our participants are heterogeneous. The sampling design—randomising villages, households and house- hold members—is robust within its scope, targeting the population in rural or semi-rural settings in Cambodia. Third, the data collection was robust and ensured a reliable data set.

Our study also had its limitations. First, it may not represent the national level as most of the study sites (villages) we selected were rural or semi-rural, which may lead to overestimating the healthcare usage in public facilities. Second, the ODs were purposively selected with oversampling the OD with interventions, increasing the service uptake in public facilities. This may lead to overestimating the public healthcare use in our study. Third, we only calculated the healthcare expenditure for those who used the service in the 3 months preceding the survey, which cannot be generalised outside this period. However, it is unlikely to be significant because we focused more on factors associated with increasing or reducing healthcare expenditure. Fourth, the sample size for people with T2D only and people with T2D plus HTN may be relatively small. Therefore, variables that were not significantly associated with the dependent variables in these groups in our study may be due to the insufficient sample size.

Conclusions

Healthcare usage at public healthcare facilities is relatively low for all groups; however, it is higher in people with chronic conditions. HEF membership and community- based care contributed the higher public healthcare usage in people with chronic conditions. Using public healthcare services, regardless of HEF status, reduced the healthcare expenditure. However, the reduction in spending was more noticeable in people with HEF membership. To protect people with T2D and/or HTN from financial risk and move in the direction of universal health coverage, the public healthcare system should further improve care quality, and expand social health protection. Future research should link healthcare use and expenditure across different healthcare models to actual treatment outcomes to denote areas for further investment.

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Contributors
SChhim, IP, VT, EW designed the study. SChhim analysed data. SChhim, VT, VB, JvO, SChham, SL, SY, WvD, EW, IP wrote the manuscript.IP is the guarantor of this study who accepts full responsibility for this work, had access to the data, and controlled the decision to publish.

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None declared.

Patient and public involvement
Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication
Consent obtained directly from patient(s)

Ethics approval
This study involves human participants and the protocol was approved by the National Ethics Committee for Human Research (NECHR) on 29 April 2019 (No. 105 NECHR) and by the Institutional Review Board of Institute of Tropical Medicine (Antwerp) on 25 October 2019 (No. 1323/19). Participants gave informed consent to participate in the study before taking part.

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Data availability statement
Data are available upon reasonable request. Data are available on reasonable request. Data are available on reasonable request to IP (ipor@niph.org.kh).

Supplemental material
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Chapter 7: Availability of Diabetes Services in Cambodian Primary Care Facilities: An Analysis of Self-Reported Survey with Health Center Staff

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Abstract

Introduction

Cambodia saw an increase in type 2 diabetes prevalence up to 9.6% among the adult population aged 18-69 years in 2016. As a leading risk factor for cardiovascular diseases, type 2 diabetes could lead to serious health complications if proper and adequate care was not available. Lack of access to essential health services and medicines for type 2 diabetes has been proven to hamper improvement in controlling disease outcomes. This study aims to assess the availability of services for type 2 diabetes in the primary care provided by health centers and their characteristics of service inputs.

Methods

This study used an existing dataset obtained from health center staff joining a national training on "Health center preparedness in response to COVID-19 spread in the community" at the National Institute of Public Health from 19 October to 01 December 2020. Data related to the availability of type 2 diabetes services and the associated characteristics of service inputs were extracted for the descriptive analysis.

Results

The dataset collected in 2020 was composed of information from 1,157 (95%) of the total 1,221 health centers in Cambodia. Among the participating health centers (n=1,157), 223 (19%) reported currently providing type 2 diabetes services at their facilities, 261 (23%) currently having anti-diabetic medicines, 740 (64%) currently having supporting infrastructure, 235 (20%) having at least one staff member ever received training about type 2 diabetes, and 320 (28%) having ever provided community education about type 2 diabetes.

Conclusions

This study indicates the limited availability of type 2 diabetes services at public primary care facilities in the Cambodian health system. The findings could be informative for health service planning for type 2 diabetes at the health center level.

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Keywords: Type 2 diabetes, Primary care, Primary health care, Service availability

Introduction

Globally, 1 in 10 adults aged 20-79 years were living with type 2 diabetes (T2D) in 2021 [1]. In Cambodia, the prevalence of T2D was 9.6% among the adult population aged 18-69 in 2016 [2]. In 2010, it was only 2.9% among the age group 25-64 [2]. The prevalence of T2D has increased faster in low and middle-income countries (LMICs), where primary health care (PHC) settings are still limited in capacity for screening, diagnosis and care management [3].

As a leading risk factor for cardiovascular diseases [3, 4], which accounted for 24% of Cambodia's total deaths in 2018 [5], T2D could lead to serious complications such as blindness, kidney failure, coronary heart disease, stroke, peripheral vascular diseases, and lower-extremity amputation if proper and adequate care was not available [1].

Cambodia's health care system is pluralistic, consisting of both public and private providers [7]. The public health care system, operated by the Ministry of Health, was established based on a district health system model, following the PHC approach. In the PHC setting, one operational health district includes a number of health centers (HCs) providing primary care to the population in the community and a referral district hospital providing secondary care. As needed, care can be referred to a provincial referral hospital or a national referral hospital that provides tertiary care [8].

By December 2019, the total number of HCs in Cambodia was 1,221 [9]. According to the national clinical guidelines on the Minimum Package of Activities, there is an indication of T2D services at the HC level [10]. HC staff are expected to do screening, provide follow-up care for T2D patients with mild and stable conditions after being diagnosed and prescribed treatment by a doctor at the referral hospital, offer health education and counseling on healthy behaviors, and refer unmanageable T2D patients to the referral hospital [10]. Nevertheless, a national population- based survey in 2016 discovered that more than two- thirds of the population never had their blood glucose tested, and those living with T2D (more than 50%) could not receive treatment [2].

A systematic review found that lack of access to T2D health services as well as anti-diabetic medicines would hamper improvement in T2D outcomes [11]. Therefore, it is essential to know the coverage of health services for T2D available at public primary care facilities in Cambodia. This study aims to assess the availability of T2D services at HCs in Cambodia.

Methods

This study used an existing dataset obtained from HC staff who received national training on "Health center preparedness in response to COVID-19 spread in the community" at the

National Institute of Public Health from 19 October to 01 December 2020. All the HCs across the country were grouped into 25 groups and were invited to attend the training group by group, with one representative from each HC.

According to the World Health Organization, service availability refers to "the physical presence of the delivery of services and encompasses health infrastructure, core health personnel and aspects of service utilization" [12]. In this study, the availability of T2D services included five dimensions: (1) reporting providing T2D services, (2) having at least one staff member ever received training about T2D, (3) having anti-diabetic medicines, (4) having ever provided community education on T2D, and (5) having supporting infrastructure for T2D services. The supporting infrastructure consisted of the availability of clean water, electricity, the internet for information transfer, and the patient management registration system (PMRS). These four components need to be available together for an HC to be considered as currently having the supporting infrastructure. Data related to the availability of T2D services were extracted by researchers (VT and SM) for the descriptive analysis using Stata 14.2 [13].

Results

In total, there were 1,157 participating HCs (95%) of the total 1,221 HCs in Cambodia (**Table 1**). Among the 1,157 HCs, only 223 (19%) reported currently providing T2D services at their facilities; 261 (23%) reported currently having anti-diabetic medicines; 740 (64%) reported currently having the supporting infrastructure; 235 (20%) reported having at least one staff member ever received training about T2D; and 320 (28%) reported having ever provided community education about T2D.

Table 1: Distribution of HCs who reported currently providing T2D services by provinces

No.	Capital/Province	Number of participating HCs	HCs reported currently providing T2D services	%
1	Pailin	5	2	40.0
2	Kampong Cham	90	35	38.9
3	Phnom Penh	39	13	33.3
4	Kampong Speu	55	16	29.1
5	Preah Sihanouk	15	4	26.7
6	Kampong Thom	51	13	25.5

7	Kandal	96	24	25.0
8	Preah Vihear	27	6	22.2
9	Kampot	62	13	21.0
10	Battambang	77	16	20.8
11	Takeo	73	15	20.6
12	Kep	5	1	20.0
13	Siem Reap	86	17	19.8
14	Svay Rieng	42	8	19.1
15	Tboung Khmum	68	13	19.1
16	Kratie	30	3	10.0
17	Banteay Meanchey	61	6	9.8
18	Kampong Chhnang	42	4	9.5
19	Steung Treng	12	1	8.3
20	Koh Kong	13	1	7.7
21	Prey Veng	106	8	7.6
22	Pursat	38	2	5.3
23	Ratanakiri	20	1	5.0
24	Oddar Meanchey	34	1	2.9
25	Mondulkiri	10	0	0.0
	Total	**1,157**	**223**	**19.3**

Figure 1 shows the five dimensions of service availability. Only 66 (25%) out of the 261 HCs currently reported having sufficient anti-diabetic medicines. In terms of the supporting infrastructure dimension, among the participating 1,157 HCs, 1,046 (90%) had clean water for use; 1,143 (99%) had electricity; and 1,072 (93%) had internet for information transfer. However, less than three-quarters (73%) had the PMRS (**Figure 2**).

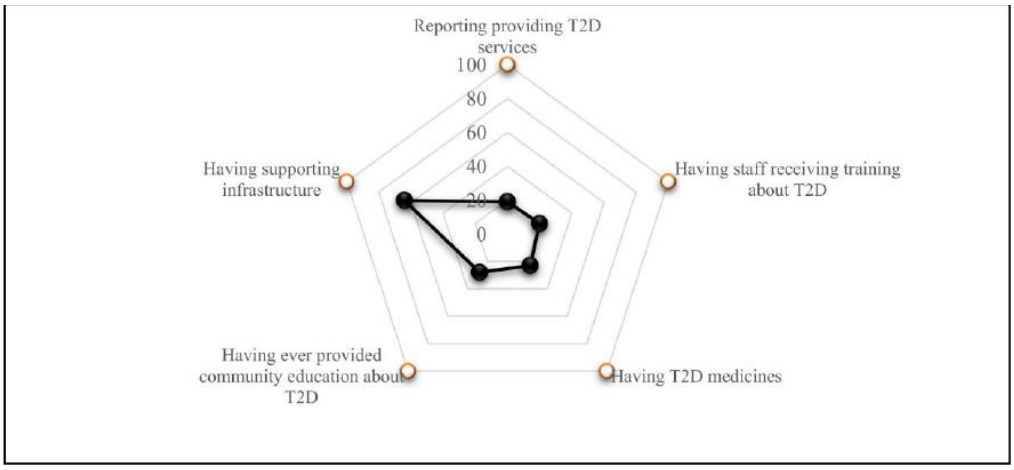

Figure 1. Availability of the five dimensions of T2D services (n=1,157 HCs)

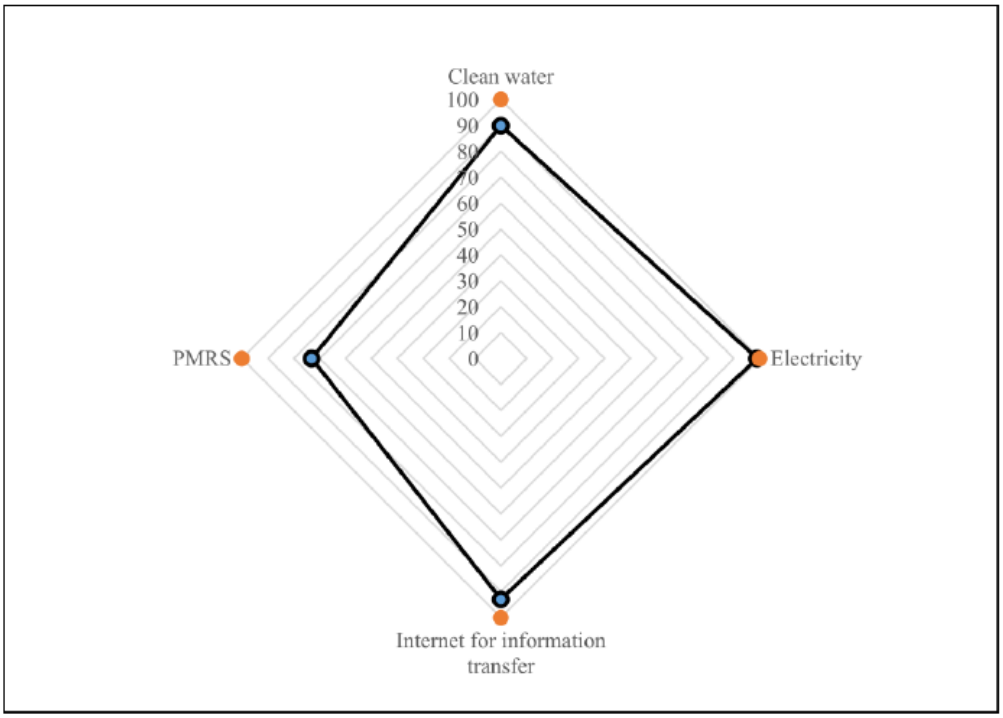

Figure 2. Availability of the supporting infrastructure components (n=1,157 HCs)

Discussion

From this study, it was clear that the availability of T2D services at public primary care facilities was limited—19%, less than 1 in 5 HCs, reported currently providing the services. Overall, less than 1 in 4 HCs (23%) of the participating HCs reported the availability of anti-diabetic medicines. Among those reporting the availability of the medicines, only 25% reported sufficiency. This indicates that the T2D services stipulated in the national clinical guidelines on the Minimum Package of Activities for HCs [10] were not fully implemented as intended. The follow-up care at the HCs would be difficult, without having sufficient medicines available for refilling the prescription, despite the availability of the supporting infrastructure, such as clean water, electricity, internet for information transfer, and the PMRS.

The communication between the HCs and the community about T2D was also limited, with only 28% of the HCs ever offering community education about T2D. According to the National Standard Operating Procedure for Diabetes and Hypertension Management in Primary Care approved by the Ministry of Health in 2019, HCs are supposed to play an active role in providing continuity and coordination between the community and the healthcare organization of the upper level of care [14]. The limited availability of the T2D services at the primary care facilities, which are closer to the community, would cause overflow of patients seeking care directly at the secondary or tertiary care level, resulting in overwhelming provision of care at the referral hospitals and increase of patients‟ healthcare costs and time in seeking care. Consequently, private providers would be seen as a better option for the patients.

The limited availability of T2D services at public primary care facilities is not exceptional in Cambodia. In Bangladesh, T2D services at the primary care level were also low, especially in rural public health facilities. Medicines and equipment for diagnostic testing were largely reported as unavailable [15]. Another study in Tanzania found that the availability of T2D services was greater in private healthcare facilities [16].

The T2D condition requires lifelong care and must be managed properly and promptly on a regular basis by patients themselves, care givers, and health care professionals to prevent or delay complications [17]. The complications impose a heavy socio-economic burden on patients themselves, families, and the country as a whole. Direct medical costs (resources used to treat the disease at an advanced stage), indirect costs (productivity lost due to morbidity, disability, and premature mortality), and intangible costs (reduced quality of life of patients) are all large [1].

This study, despite having a large sample size (95% of the total HCs in the country), was based on self- report. The timeframe of the availability of each dimension was not totally clear. Although the data were collected in 2020, dimensions on staff training and community education did not clearly indicate when the training was provided and whether the staff ever

receiving the training still worked for the respective HCs. This also applied to the community education dimension. There was no indication of when and how many times the education was given to the community. Regarding the dimensions on the reporting providing T2D services, anti-diabetic medicines and supporting infrastructure, the timeframe indicated in the questionnaire was being „current". The findings were more descriptive but could be informative for health service planning for T2D at the public primary care facilities.

Conclusions

This study indicated the limited availability of T2D services in the public primary care of the Cambodian health system. The service coverage in the country was low, less than 1 in 5 HCs. The findings provide a situational and descriptive snapshot of T2D services at the public primary care facilities, which would be a useful baseline for health policy makers or other relevant stakeholders to plan or strengthen the services. More than half of the total HCs already had the supporting infrastructure. To strengthen the service availability at the HCs, more effort should be targeted on training the core staff about T2D, improving communication between the HCs and communities about T2D, and ensuring adequacy of the anti-diabetic medicines at the facilities. For a more comprehensive service availability and readiness assessment, an implementation study with field visits and interviews with relevant health care providers should be conducted.

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Authorship

All authors took part in conceptualizing the study design. VT and SM extracted the data, performed the analysis, and prepared the first draft. PI, CC, PH, and SL provided feedback on the drafts. All authors read and approved the final manuscript.

Ethical Approval

The dataset was granted by the National Institute of Public Health to be used as part of knowledge sharing purpose. Therefore, formal ethical approval was not deemed to be required.

Declaration of Conflicts of Interest

The authors declare that there are no conflicts of interest.

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Chapter 8: An in-depth analysis of the degree of implementation of integrated care for diabetes in primary health care in Cambodia

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Abstract

Introduction

With the rising prevalence of type 2 diabetes (T2D), three care models for T2D are being scaled-up in Cambodia to improve availability and accessibility of integrated care for T2D: (1) *hospital-based care*, (2) *health centre-based care*, and (3) *community-based care*. This study aims to conduct an in-depth analysis of the implementation of the three care models either individually or in co-existence and identify each care model's potential contributions towards integrated care.

Methods

Twenty public health facilities in five operational districts were assessed on six integrated care components: (1) early detection and diagnosis, (2) treatment in primary care services, (3) health education, (4) self-management support, (5) structured collaboration, and (6) organisation of care. Two raters independently scored each facility on a 0-5 scale based on multiple sources of data and reached a consensus. Contributions were potentially identified when presence of a particular care model consistently increased a particular component score across the selected operational districts.

Results

The in-depth analysis showed that the three care models were not implemented in an integrated manner, with low implementation scores (1 or 2 out of 5) in all selected settings. The presence of health centre-based care was associated with higher scores for early detection and diagnosis and treatment in primary care services, while the presence of community-based care was related to structured collaboration and organisation of care.

Conclusions

The evidence suggests that while each model has its potential contributions towards integrated care for T2D, the three care models should be effectively implemented in an integrated manner in order to potentially produce the desired outcomes.

Keywords: diabetes care, integrated care, innovative care for chronic conditions, primary health care

Introduction

In 2021, globally, 537 million adults aged 20-79 years were living with type 2 diabetes (T2D), of which over three quarters were living in low- and middle-income countries (LMICs) [1]. While the increase in T2D prevalence has been the most rapid in LMICs, the capacity of primary health care (PHC) for screening, diagnosis, treatment, and care management is still limited in these contexts [2]. Cambodia, a LMIC in the World Health Organisation (WHO) Western Pacific region – the region with the highest number of adults living with T2D [1] – has experienced a significant increase in T2D prevalence in the last 10 years: 9.6% of adults aged 18-69 were found to live with T2D in 2016, while it was 2.9% amongst the 25-64 age group in 2010 [3]. The Cambodian PHC system has limited capacity for meeting the needs of the population at risk and those already living with T2D: more than two-thirds of the population have not had their blood glucose level tested; more than half of those living with T2D are not receiving treatment; and only few of those receiving treatment achieve recommended treatment targets [3].

T2D that is not properly and adequately managed could rapidly lead to complications [1] – the major complications are cardiovascular diseases [2, 5] which accounted for 24% of the Cambodia's total deaths in 2018 [1]. Lack of access to T2D care including anti-diabetic medicines has been found to negatively affect outcomes [7]. Due to its asymptomatic and progressive nature, incurability, and chronicity, T2D management requires a continuum of preventive, curative and care services in place, preferably in an integrated manner, to prevent or delay complications [8, 9]. An integrated care implies that involved care providers share necessary information and coordinate resources in an effective and efficient manner across the care continuum and involved care providers [10]. The WHO developed the Innovative Care for Chronic Conditions (ICCC) framework for health system transformation towards the integrated care for chronic disease management [8]. The ICCC framework was adapted from the Chronic Care Model [11] which has been found to be effective for the management of T2D in primary care in terms of improved clinical outcomes [12-19]. The ICCC framework, however, is more comprehensive and applicable to a wider international context including LMICs [8, 20].

In Cambodia, the Ministry of Health oversees the overall health system, which is pluralistic, consisting of both public and private providers (including non-profit organisations). Cambodia follows the PHC approach to operating public health care on a district health system model. In this approach, one operational health district (OD) contains approximately 10-25 health centres (HCs) providing primary care – commonly known as a minimum package of activities [21] – to communities with support of community health workers and a referral hospital (RH) which provides secondary care complementary to the HCs. Severe cases can be further referred for tertiary care at a national referral hospital [21]. Only approximately one in five HCs reported providing T2D services [22] despite national clinical guidelines clearly stating activities for T2D care at all HCs [23].

Three care models for T2D are being scaled-up across the 103 ODs to improve the availability and accessibility of the integrated care for T2D in Cambodia: (1) *hospital-based care*, (2) *health centre-*

based care, and (3) *community-based care*. The care models are mentioned in the 2019 national standard operating procedure for the management of T2D and hypertension in primary care [24]. This standard operating procedure was adapted from the WHO package of essential noncommunicable disease interventions (WHO PEN) [25] with the intention to apply PHC approach to T2D care in which HCs offer the continuity of care and coordination across the care levels in the OD – HCs implementing the standard operating procedure are defined as HCs with WHO PEN. Hospital-based care is provided at RHs focusing on confirmation of diagnosis, treatment initiation and treatment of serious or complicated T2D cases. Health centre-based care is provided at the HCs with WHO PEN to screen for T2D (targeting the population aged 40 and over), provide follow-up care for mild and stable T2D cases without complications, and offer counselling on positive lifestyle changes. Community-based care is offered by community health workers – operating in either a village health support group formally recognised by the Ministry of Health or a peer educator network supported by a Cambodian non-governmental organisation called MoPoTsyo – providing support to the HCs. The peer educators – also people living with T2D – offer self-management support to people with T2D in their network and assist them to have access to physician consultation, laboratory tests, and low-cost medicines through a revolving drug fund program [26].

At the implementation level, to achieve better outcomes for chronic conditions, the ICCC framework gives emphasis on a triad interaction between people with chronic conditions and their families, the health care team, and community partners; with support from both the health care organisation and the community. Therefore, it could be expected that the co-existence of the three care models in an OD would theoretically represent an ideal context for the integrated care for T2D [8]. Te *et al.* [27] used the HIV test-treat-retain cascade of care [28] to quantitatively assess the care continuum for people living with T2D from stages of testing, diagnosis, linkage with care, retention in care, adherence to treatment, to reaching treatment targets in ODs with availability of the above-mentioned care models either individually or in co-existence. The study was population-based and its results showed that the OD with the co-existence of care had the worst cascade of care across all the stages, while the OD with the hospital-based care had the best [29]. This discovery was unexpectedly contradictory to the ICCC theoretical framework [8] and thereby rendered a systematic investigation of the actual implementation of the care models in those ODs a clear research priority [27]. In addition to the need for knowledge on potential implementation gap, there is also a clear need for knowledge on how each of the care models contributes to the integrated care for T2D in Cambodia. As a response, this study aims to conduct an in-depth analysis of the implementation of the three care models either individually or in co-existence and identify each care model's potential contributions towards the integrated care for T2D as defined by the ICCC framework.

Research Methods

Study type and settings

This was a qualitative study with a quantifiable scoring assessment. It is part of a larger study of the Scale-up of Diabetes and Hypertension Care for Vulnerable People in Cambodia, Slovenia and Belgium (SCUBY) [30]. Data were collected from June-August 2019 in five ODs located in five provinces in Cambodia – the same ODs that were included in the population-based survey of Te *et al.* [27, 29]. The ODs were purposively selected to represent the care models either individually or in co-existence. **Table 1** shows the five ODs hosting the three care models either individually or in co-existence at the time of data collection.

The five ODs with the care models were: 1) OD Daunkeo in Takeo province conducted the three care models together, which only co-existed in this OD. The hospital-based care was provided at a Chronic Disease Clinic [31] which provided treatment and care to both people with T2D and/or hypertension and those with HIV [31] – the clinic was essentially a Non-Communicable Disease (NCD) clinic of the RH, WHO PEN was implemented in eight out of 15 HCs (health centre-based care), and the community-based care was provided by the MoPoTsyo peer educator network. 2) OD Pearaing in Prey Veng province conducted the health centre-based care where WHO PEN was implemented in eight out of nine HCs (i.e. high coverage). 3) OD Sotr Nikum in Siem Reap province conducted the health centre-based care – with historical and significant influence from various development partners and non-governmental organisations (a contextual factor) – where WHO PEN was implemented in five out of 25 HCs (i.e. low coverage). In this OD, the Chronic Disease Clinic was also operating in the Sotr Nikum RH. 4) OD Kong Pisey in Kampong Speu province conducted the community-based care model organised by the peer educator network. The RH in this OD did not formally offer care for T2D, but the peer educator network made the arrangement with the RH to provide physician consultations for people with T2D in the network once a week. 5) OD Samrong in Oddar Meanchey province conducted the hospital-based care in the NCD clinic of the Oddar Meanchey RH – the only public provider of T2D care in the OD.

Table 1. Five ODs and the availability of care provision for T2D

OD	Province	Existing care provision	Care Model
1) Daunkeo	Takeo	NCD clinic + WHO PEN + Peer Educator Network	Co-existence of the three care models
2) Pearaing	Prey Veng	NCD clinic + WHO PEN (high coverage)	Health centre-based care
3) Sotr Nikum	Siem Reap	NCD clinic + WHO PEN (low coverage)	Health centre-based care with context
4) Kong Pisey	Kampong Speu	Peer Educator Network	Community-based care
5) Samrong	Oddar Meanchey	NCD clinic	Hospital-based care

Participants and instrument

In each OD, we assessed the RH and three randomly selected HCs – each OD is a unit of analysis. In total, five RHs and 15 HCs were assessed. Relevant management team and staff members in the selected health facilities were also interviewed as a part of data collection.

The ICP grid which stands for Integrated Care Package Implementation Assessment Framework was the instrument we used to assess the integrated care for T2D and was developed based on two assessment tools that have been validated and widely used in high- and low-income settings to assess integrated care for chronic conditions: (1) the Assessment of Chronic Illness Care Form [32] and the ICCC Framework Situation Assessment Form [33]. The ICP grid allowed us to measure six components of the integrated care including: (1) early detection and diagnosis, (2) treatment in primary care services, (3) health education, (4) self-management support, (5) structured collaboration, and (6) organisation of care. In total, there were 32 questions or items related to implementation of T2D care in Cambodia (**Table 2**). This entails the availability of structures necessary for the service provision (e.g. basic equipment for diagnosis, standard guidelines, essential medicines, trained staff, etc.) and the processes of service operation. The ICP grid has already been successfully applied in Slovenia [34]. It was translated into Khmer (Cambodian national language) and field tested before the actual data collection in the five ODs. **Appendix 1** shows details of the ICP grid.

Table 2. Questions of each ICP component in the grid

ICP Components	Questions/ Items
Component 1: Facility-based identification of patients with T2D	**1.1.** To what extent, is screening for T2D performed among patients at a visit? **1.2.** To what extent, are equipment and materials necessary for diagnosing patients for T2D available at the facility? **1.3.** To what extent, are health care staff or service providers competent to perform diagnosis for T2D at the facility? **1.4.** To what extent, is the follow-up of the patients after the screening, testing and diagnosis of T2D organised?
Component 2: Treatment of T2D by primary care providers using standardised protocols	**2.1.** To what extent, are written guidelines of care and treatment accessible to primary care providers for T2D? **2.2.** To what extent, are primary care providers in charge competent to provide treatment for patients with T2D? **2.3.** To what extent, are the essential medications for T2D available in the primary care setting? **2.4.** To what extent, do primary care providers have necessary laboratory access?

	2.5. To what extent, have primary care providers received training for treating T2D? **2.6.** How comprehensive is treatment beyond medication prescription for T2D (including measuring of body mass index, waist circumference, blood pressure, cholesterol level, renal function, screening for complications – foot examination, eye problem, macrovascular disease, depression)? **2.7.** To what extent, are medication reviews undertaken in the elderly with T2D in order to avoid polypharmacy, hypoglycemia and renal dysfunction?
Component 3: Health education and counselling to patients with T2D by non-physician care providers	**3.1.** To what extent, do patients with T2D receive information on how to reduce health risks by non-physicians? **3.2.** To what extent, are patients informed about the chronic condition of T2D by non-physicians (including the expected course, expected complications, and effective strategies to prevent complications and manage symptoms)? **3.3.** To what extent, are non-physicians trained to provide health education and counselling to patients with T2D? **3.4.** To what extent, are health education or counselling materials accessible to non-physicians for T2D?
Component 4: Self-management support to patients and their informed caregivers with tools for adherence and monitoring	**4.1.** To what extent, are patients offered self-management training for T2D (for example, to improve adherence to medications, proper nutrition, having self-monitoring tools at home, consistent exercise, tobacco cessation, and maintain other healthy behaviours)? **4.2.** To what extent, do health care staff or community health workers support patients' self-management efforts on a continuous basis for T2D? **4.3.** To what extent, are health care staff or community health workers competent to perform self-management training? **4.4.** To what extent, does the patient have access to materials for self-monitoring for T2D, for instance, glucose meter/ glucose test strips? **4.5.** To what extent, are informal caregivers/non-medical involved in the self-management process for T2D? **4.6.** Are the concerns of patients and families addressed? **4.7.** Are patient treatment plans agreed with patients, reviewed and written down?
Component 5: Structured collaboration between health	**5.1.** To what extent, is there an identified "care coordinator" who serves as the overseer and director of a patient's care, ensuring that efforts of all involved health care workers, community actors, and patients and caregivers are integrated and coordinated for T2D?

care workers, community actors, and patients and caregivers	**5.2.** To what extent, do the health care organisation and the community have complementary functions, that is, the community organisation fills gaps in services that are not provided in formal health care for T2D? **5.3.** To what extent, are referral practices systematically organised for T2D? **5.4.** To what extent, does cooperation between health care workers and other professionals and community actors occur for T2D? **5.5.** To what extent, is the traditional hierarchy flattened and moved away from physician-dominated models for T2D?
Component 6: Organisation of care, delivery system design and clinical information systems	**6.1.** To what extent, are ongoing quality improvement routine activities among health care workers organised? **6.2.** To what extent, do information systems gather and organise data about epidemiology, treatment, and health care outcomes? **6.3.** To what extent, do information systems serve as a reminder function for patient specific prevention and follow-up services (e.g. to identify patients' needs, follow-up and plan care, monitor responses to treatment, and assess health outcomes)? **6.4.** To what extent, is feedback about the performance provided to the team and its members? **6.5.** To what extent, is an appointment system with planned visits used?

Data collection and analysis

Figure 1 shows the flow of data collection for each OD visit. Each question of the ICP grid was given a score based on the synthesis of multiple sources of data collection. The data sources were obtained from: (1) participant observation at the health facilities during the operations; (2) key informant interviews with the director or deputy director of the respective provincial health department, OD, and RH; (3) focus group discussions with health care staff from the respective NCD clinic and HCs and with community health workers including the village health support group and peer educator network; (4) focus group discussions or in-depth interviews with patients with T2D who were either referred or selected at the health facilities; and (5) inspection of documents at the health facilities (e.g. management book, patient registry book, outpatient record book, patient files, etc.). Two raters independently scored each health facility and then reached a consensus final score through discussion. The consensus between the raters was reached facility by facility with verification of the data collected (recordings, memos, photos, etc.) and the discussions were documented. The scoring system was based on a 0-5 scale: 0= 'no implementation', 1= 'little implementation', 2= 'lower moderate implementation', 3= 'upper moderate implementation', 4= 'almost complete implementation', and 5= 'full implementation'. Detailed explanation of each scale for each question can be found in Appendix 1.

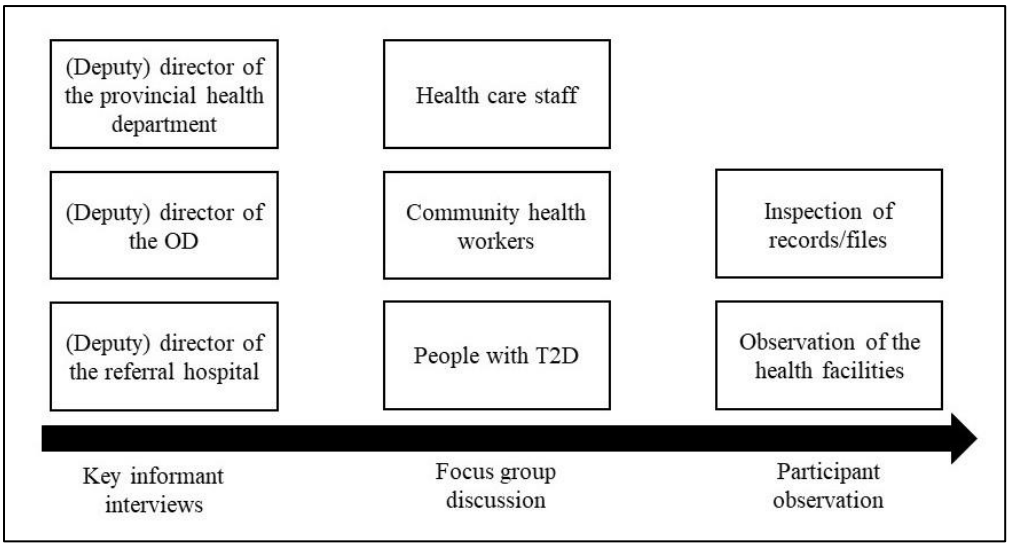

Fig. 1. Flow of data collection for each OD visit

For each OD, a score was generated per ICP component based on the mean of the scores for all the questions under each component. The score for each question, nevertheless, was based on the mode of the assessed health facilities, given that the data were categorical by nature. Potential contributions were identified when presence of a particular care model consistently increased a particular component score across the selected ODs.

Ethics Approval

The study obtained ethical clearance from the National Ethics Committee for Health Research in Cambodia with reference number 105 NECHR and the Institutional Review Board of Institute of Tropical Medicine (Antwerp) with reference number 1323/19.

Results

In total, five RHs and 15 HCs were assessed. Thirteen focus group discussions were conducted (four to six people per group); and 16 key informant interviews were carried out.

Generally, the implementation scores were low across the ICP components in all the selected ODs (**Table 3**). The presence of WHO PEN tended to produce higher scores for early detection and diagnosis (ICP1) and treatment in primary care services (ICP2), while the presence of the peer educator network for structured collaboration (ICP5) and organisation of care (ICP6). The co-existence of care was likely to generate better scores across the ICP components. **Figure 2** shows the spider chart representing the ICP components of the care models either individually or in co-existence. Detailed assessment scores of the ICP components by each question are included in **Appendix 2**.

Table 3. Summative scores for each ICP component across the care models

ICP Component	Hospital-based care	Health centre-based care	Health centre-based care with context	Community-based care	Co-existence of care
	NCD clinic	NCD clinic + WHO PEN (high coverage)	NCD clinic + WHO PEN (low coverage)	Peer Educator Network	NCD clinic + WHO PEN + Peer Educator Network
Early detection and diagnosis (ICP1)	0	3	2	1	3
Treatment in primary care services (ICP2)	0	1	1	0	1
Health education (ICP3)	0	1	1	1	2
Self-management support (ICP4)	0	1	1	1	2
Structured collaboration (ICP5)	1	1	1	2	2
Organisation of care (ICP6)	2	2	2	3	2

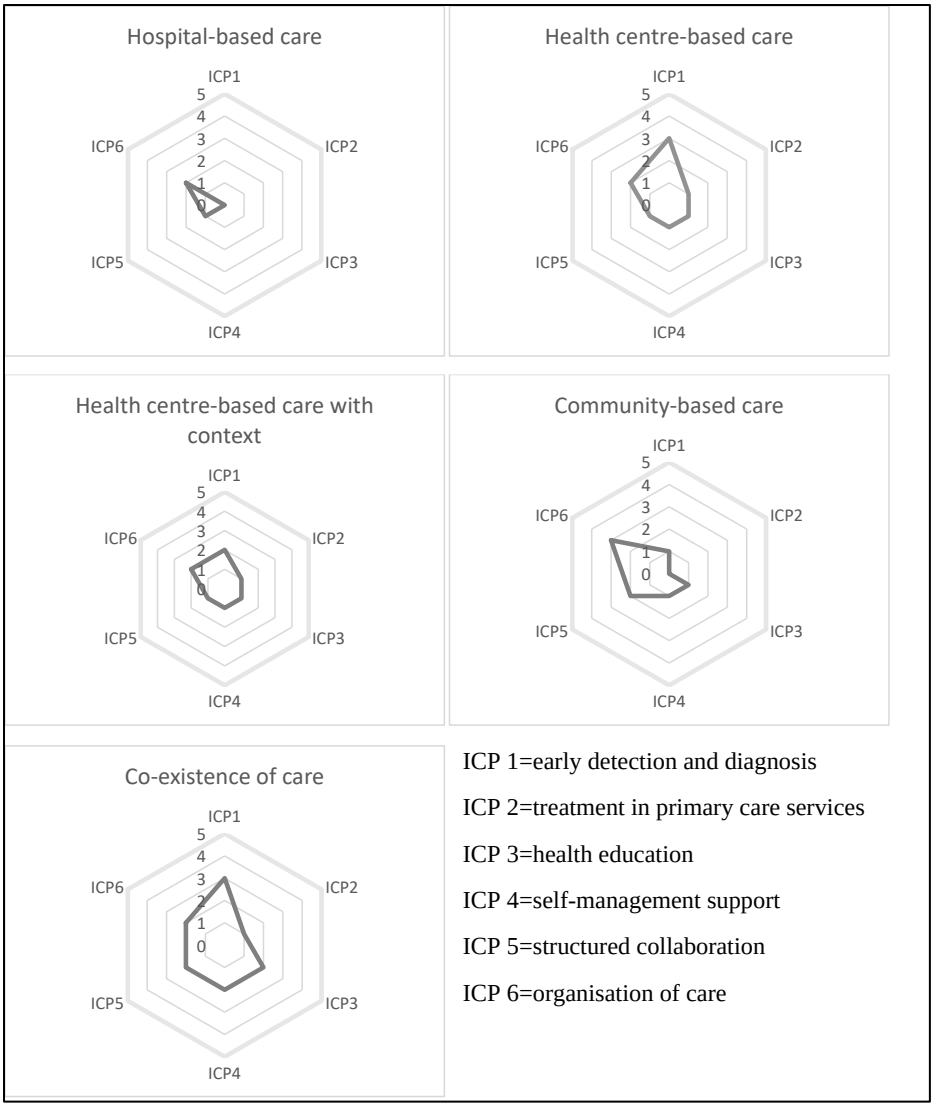

Fig. 2. Spider chart representing the ICP components of the care models either individually or in co-existence

Facility-based identification of people with T2D (ICP1)

Under this component, four items were assessed. Most HCs in the ODs with WHO PEN (health centre-based care) achieved a score of 2 for screening T2D amongst patients at a health facility visit (Item 1.1), meaning that the HCs could perform screening for T2D amongst patients when there was the presence of T2D symptoms or clinical requirements by other conditions. The score of 5 could be achieved if everyone who needs to be tested got tested. Most of the HCs in the ODs with WHO PEN had the necessary materials and equipment available for diagnosing a small number of patients (score of 3) – compared to the score of 5 'fully equipped for everyone' (Item 1.2). In terms of competency to perform the diagnosis procedure (Item 1.3), HC staff in the ODs with WHO PEN could conduct diagnosis with limited interpretation of the results (score of 4),

while the score of 5 denotes the clear interpretation of the results. In addition, patients with a positive screening result were more likely to be followed up by the HC staff (score of 3), while the score of 5 indicates care that is organised and planned for every patient and they would be called if non-attending (Item 1.4).

HCs in the OD with hospital-based care, in regard to this component, scored poorly (mostly score of 0 or 1 across the items). There were no written guidelines on the management of T2D, equipment and materials for T2D screening, or staff trained on T2D (except a few medical doctors who received training as part of their formal education and occasionally on the job training). This situation at HCs was also found in the OD with community-based care. These HCs mainly referred patients to the peer educator network, which only worked closely with the RH.

Among the RHs, the one in the OD with hospital-based care got the best scores (score of 3 for the screening, score of 5 for having necessary equipment and materials for diagnosis, score of 5 for having health care staff competent to conduct diagnosis, and score of 3 for the patient follow-up).

Treatment of T2D by primary care providers using standardised protocols (ICP2)

There were seven items assessed under this component. It was observed that in the ODs with WHO PEN (health centre-based care), HCs could do more activities in this component due to the availability of certain structures. For example, one HC could easily access the recent national standard operating procedure for the management of T2D at the facility (score of 3). To get the score of 5, recent updated guidelines have to be available and integrated in daily practice through reminders (pop-ups) in electronic medical records tailored to each patient (Item 2.1). Regarding competence on treating T2D (Item 2.2), two HCs had staff with detailed knowledge and non-pharmacological skills plus basic pharmacological knowledge in treating T2D (score of 3). One HC had two or more anti-diabetic essential medicines for T2D available at the facility (score of 4). The score of 5 could be given only when all the essential medicines (including insulin) were fully accessible at the facility (Item 2.3). Staff (who were medical doctors) at two HCs reported receiving training for treating T2D as part of their formal education and occasionally on the job training (score of 3). Regarding items on how comprehensive treatment is given (Item 2.6) and medication reviews are undertaken with the elderly patients (Item 2.7), most of the HCs (even with WHO PEN) could not perform them. Four HCs could only perform some elements of treatment such as measuring weight, height, waist circumference, and blood pressure (score of 1).

In ODs without WHO PEN (hospital-based care and community-based care), scores for treatment of T2D by primary care providers were mostly zero across the items except one HC having a medical doctor. That HC scored 2 (having non-pharmacological knowledge and skills to treat T2D) for the item 2.2 and also 2 (part of the formal education) for the item 2.5 on training for treating T2D.

Items under this component which focuses on treatment of T2D by primary care providers are not applicable to RHs that provide secondary care.

Health education and counselling to people with T2D by non-physician care providers (ICP3)

For this component, four items were assessed. There was not much difference at the RH level between ODs with or without WHO PEN except that the RH in the OD with hospital-based care got the score of 5 for having all the necessary health education or counselling materials fully accessible to nurses for T2D (Item 3.4). However, there was a difference at the HC level. In the ODs with WHO PEN, patients could receive information on how to reduce health risks from nurses or community health workers albeit not in a structured way (Item 3.1) at four HCs (score of 2). Similarly, patients were informed about their T2D condition by nurses within consultation (Item 3.2) at three HCs (score of 2). Regarding training on providing health information and counselling to people with T2D (Item 3.3), nurses at eight HCs reported receiving training when the HCs started WHO PEN and occasional training later on (score of 2 or 3), while the score of 5 requires them to systematically receive extra mandatory trainings with innovative methods. There was evidence that posters and /or brochures about T2D (if not all) were accessible (Item 3.4) at one HC (score of 4).

In ODs without WHO PEN (hospital-based care and community-based care), scores for health education and counselling to people with T2D by non-physician care providers were mostly zero across the items.

Self-management support to patients and their informed caregivers with tools for adherence and monitoring (ICP4)

Seven items were assessed under this component. At the HC level, there was not a clear difference in pattern between ODs with or without WHO PEN except for patients having access to materials for self-monitoring of T2D, such as a glucose meter and glucose test strips (Item 4.4). At four HCs in the ODs implementing WHO PEN, some but not all patients had access to all the materials needed (score of 3).

The RH of the OD which had a collaborative partnership with the peer educator network (community-based care) performed noticeably better on three out of seven items: 1) it fully involved informal caregivers (Item 4.5) with knowledge of self-management but no provision of supporting materials (score of 4); 2) it addressed the patients' concern (Item 4.6) through the peer educator's mentoring program (score of 4) but not in a systemic assessment that is an integral part of primary care; and 3) patient treatment plans with clinical goals were recorded in a patient record book (Item 4.7) and self-management (no follow up care) was established collaboratively with patients (score of 4). People with T2D received follow-up support from the peer educators, and patients could come to the peer educators for blood glucose testing and measurements of blood pressure, weight and waist, with a fixed fee determined by the network.

Structured collaboration between health care workers, community actors, and patients and caregivers (ICP5)

For this component, five items were assessed. Peer educators in the community-based care OD were active in playing a role as a care coordinator (Item 5.1) but not in a structured way (score of 4). They made insufficient effort to fill gaps in services (Item 5.2) that were not provided in formal health care for T2D (score of 3). Referral practices (Item 5.3), while expected to be systematically done in a two-way written communication for all cases with confirmation via tele-communication, were done mostly in a one-way written communication regardless of ODs (score of 2). Cooperation within but not beyond a team (Item 5.4) was observed in the RH of the OD with community-based care (score of 3). A group of peer educators made all the preparatory arrangements for the physician consultation at the RH for the patients in their network. The network also made use of the public health facilities for dispensing medicines through their revolving drug fund program and for the laboratory service.

The traditional hierarchy (Item 5.5) in which medical doctors are central and other health care workers play a minor role was still applied (score of 2) across the ODs. The score of 5 denotes the flattened hierarchy that moves away from the physician dominated model and health care workers with special training in chronic care can take the lead.

Organisation of care, delivery system design and clinical information systems (ICP6)

This component focused on the organisation of care consisting of 5 items. No specific pattern was observed with the NCD clinic and WHO PEN but with the presence of peer educator network in the community-based care OD. All the selected health facilities across the ODs were similarly affected by national policies such as Cambodia Health Equity and Quality Improvement Project (H-EQIP) – designed to improve access to quality health services at public health facilities – and Patient Management and Registration System (PMRS). The H-EQIP required ongoing quality improvement activities (Item 6.1 & 6.4) of health care workers to be performed every quarter but there was no guarantee that results from previous rounds were taken into account (score of 4). The PMRS included demographic information about each patient but clinical information was very limited (Item 6.2), and the appointment system (Item 6.5) used an appointment card and so could not ensure a reminder function (score of 2). The score of 5 could be given when the appointment system enabled the patient to see multiple providers in a single visit. We noticed that, in the community-based care OD, patients' health information was more organised through the network's database which was useful for treatment and reminder purposes (Item 6.3). In the OD with co-existence of care, although the peer educator network was present, its functionality had declined after being handed over to a local health governance.

Discussion

The study showed in-depth analysis of implementation of the three care models either individually or in co-existence. There was pattern of contributions each care model potentially made to each care component of the ICP.

The ICP scores demonstrated that the presence of WHO PEN was observed to contribute noticeably towards early detection and diagnosis (ICP1) and minimally towards treatment in primary care services (ICP2). It was observed that the presence of WHO PEN in the ODs with health centre-based care and co-existence of care was likely to increase capacity for early detection of people with T2D at the HC level. With WHO PEN, HCs received one-time support from the national level, making them fulfilling some of the activities of T2D services stipulated in the minimum package of activities for HCs [23]. HC staff received training on T2D at the start of implementation, and HCs were supplied with equipment and materials for screening and health education. However, program sustainability and implementation fidelity were questionable. When the equipment and materials were out of order or stock, related activities were usually halted. There was evidence of expired testing strips and of unused equipment and materials that were provided, indicating a low priority given to the program.

WHO PEN emphasised and reinforced the screening activity for T2D at HCs, especially in the population aged 40 and over, but diagnosis and initial treatment still have to be made at the RH. T2D treatment at the HCs is still restricted [24] as HCs are mostly operated by nurses and midwives who are not adequately informed about T2D treatment in their formal education. Hence, the Central Medical Store, a governmental institution responsible for storing and dispensing medical equipment and drugs, will not supply anti-diabetic medicines to HCs. Although the national standard operating procedure allows the HCs with WHO PEN to refill prescriptions for stable cases of T2D [24], unavailability and inadequacy of antidiabetic medicines at the HCs were widely evidenced. This issue of inadequacy in essential medicines such Metformin, Gliclazide, etc. was also highlighted in a study of WHO PEN implemented in Myanmar [35]. The shortage of medicines, nevertheless, was not the case in a pilot study in Bhutan where strong supportive supervision from the higher up was available [36].

Peer educator networks in ODs with either community-based care or co-existence of care were likely to increase scores for structured collaboration (ICP5). However, the network was not formalised in the public health care system and mainly received support from the non-governmental organisation. The linkage function of the peer educator is however also vulnerable to change. This is seen in the OD with co-existence of care, where the peer educator network had been handed over to the local health governance and technical or financial support from the organisation disappeared, rendering the network dysfunctional. From the community side, the peer educators have the potential to play a complementary role filling in the gaps in T2D service provision, as also evidenced in other studies [26, 37]. A considerable number of systematic reviews in other countries have found that peers can effectively provide self-management

support to patients as they share similar experience, knowledge, and other characteristics to the patients [38, 39]. Likewise, lay people (such as the village health support group) who are not necessarily patients themselves can also provide effective self-management support to patients [40-44]. Community health workers, either peer educators or village health support group, need to be equipped with necessary software (knowledge and skills) and hardware (medical equipment and supplies), and motivated to provide complementary care to that of the health care workers in order to support government plans to strengthen the PHC [8, 45]. Lessons learnt from Samoa on implementation of WHO PEN showed that training local facilitators who were basically community health workers on use of data recording and patient monitoring tools such as recording patients' socio-demographic information, anthropometric measurements, known symptoms and risk factors yielded positive results on screening and community engagement in the program [46]. Regarding the organisation of care (ICP6), peer educator network's database was observed in the OD with community-based care to be a crucial local health information system for the continuity of care.

No care model under this study seemed to make a noticeable contribution to health education and counselling (ICP3) and self-management support (ICP4) to people with T2D to improve their adherence to medications and recommended lifestyle. Self-management support was also found to be weakly implemented in Slovenia [34].

Despite the contributions identified above, the ICP scores were generally low around 2 which is 'lower moderate implementation'. The co-existence of care seemed to have better scores due to the combined contributions, but the co-existence did not automatically generate synergism necessary for the optimum integrated care for T2D. The three care models were not implemented in an integrated way but rather in isolation with limited interaction between them. Working mechanisms facilitating the integrated care for T2D in terms of shared necessary information and coordinated resources [10] were not observed. There was no proper system for following-up patients for the continuity of care – the peer educator network in the OD with co-existence of care was not functioning optimally. The referral system between the communities, HCs, and RHs was dysfunctional. The patient record was still paper-based and the form was usually filled with insufficient information. At the NCD clinic of the RH, there was use of a database, but there was ineffective and inefficient use of it in connection to other public health facilities at different levels of care. The peer educators did not work closely with the village health support group or even the HCs. With insufficient resources, capacity and commitment, management teams at the OD and the provincial health department levels could not provide regular supervision and support for the implementation. The findings in the current study help to explain why the findings in the previous study [29] on the cascade of care showed that the OD with co-existence of care models did not lead to better outcomes, despite the assumption underlying the ICCC framework that the combination of health care orgnaisation and community represents an ideal context for the integrated care for T2D [8].

OD with hospital-based care scored the lowest, compared to other ODs. This was resulted from the use of mode to determine the overall score for each care component. Three HCs scored

mostly zero from ICP1 to ICP4, making the overall scores for these components zero despite the RH achieving comparable scores to other RHs. The current findings strengthen the assumption that the cascade of care – which was the best among the others – of the hospital-based care observed in the previous study [29] could have been confounded by the dominant role of private providers – since the NCD clinic was the only public provider offering T2D care in the OD.

The strengths of this study were: 1) the triangulation of evidence obtained from multiple sources of data gathered from large geographical spread in the country and 2) the close examination of implementation of the three care models either individually or in co-existence. Despite these strengths, the study also has its limitations. First, the qualitative nature with the purposive selection of ODs has limited its generalisability. Second, the one-time visit at each health facility by the raters could limit the reliability of scoring the process-related items, in particular items about coverage and competence. Third, the authors did not make an attempt to generate the overall score of the integrated care for each OD, noting that the overall score could be misleading and mask the essence of specificity. Also, the contributions of each care model were based on observed patterns of scores without statistical analysis. Fourth, this study could not capture the role of the growing private-for-profit providers, which have been dominantly utilised by the patients [47], in the integrated care for T2D.

Conclusions

Despite limitations, this study, with the use of the ICP grid, allowed us to systematically analyse the degree of implementation of the three care models either individually or in co-existence and identify their contributions towards the integrated care for T2D in the Cambodian PHC. Each of the three existing care models has its potential contributions towards different care components of the ICP. Health centre-based care was likely to produce higher capacity in early detection and diagnosis (ICP1) and treatment in primary care services (ICP2), while the community-based care tended to produce better results for structured collaboration (ICP5) and organisation of care (ICP6). No care model seemed to make a noticeable contribution to health education and counselling (ICP3) and self-management support (ICP4). The close examination of co-existence of care showed that they were not implemented in an integrated way and as intended in the written guidelines. For policy implications, while scaling-up the three care models, further effort should be put to explore factors enabling the three care models to be implemented in an integrated way according to the ICCC framework. The role and contribution of private-for-profit providers in the integrated care for T2D should also be explored.

Additional Files
Appendix 1. Integrated Care Package Implementation Assessment Framework _ ICP Grid
Appendix 2. Assessment scores of the ICP components by each item

Author Contributors
VT and SL conducted the data collection and assessment. VT prepared the first draft. All the authors provided feedback on the drafts. All authors read and approved the final manuscript.

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Competing interests
None declared

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Part 3: General Discussion and Conclusions

- Chapter 9: General Discussion
- Chapter 10: Conclusions and Recommendations

Part 3: General Discussion and Conclusions

Chapter 9: General Discussion

Our findings in perspective

This doctoral thesis evaluated the performance of the three DCIs (hospital-based, health center-based, and community-based) implemented in Cambodia according to the national standard operating procedure for T2D and hypertension managment in primary care [1], which is a reflection of the ICCC framework.

We found, through the cross-sectional population-based survey, that the unmet needs were high across the T2D care continuum (Chapter 5). Overall, the cascade-of-care displayed significant drops at the testing stage and the control stage, indicating that all the selected ODs, regardless of the DCIs present, have limited capacity in detecting those having T2D and controlling the condition (blood glucose control) in those with T2D despite receiving the treatment. The findings were consistent with the T2D cascade analyses in other LMICs displaying significant losses at the testing stage [2]. However, the proportion of people being 'in control' in this study was exceptionally low. In other LMICs, with the cut-off point of HbA1c level < 8 %, the proportion of those with the control status was 23% [2], while only 11% of the total prevalence (n=560) in this study. The drop between the treatment stage and in control stage observed in this study was much larger in comparison to the studies in other LMICs—38% in this study while only 15% in other LMICs [2]. It is noted that the clinical standard care goal for blood glucose control is HbA1c level < 7% according to the American Diabetes Association [3]. However, HbA1c of 8% is considered as a "take action" threshold and has been used as a cut-off point of poor blood glucose control in previous epidemiological studies [2, 4, 5]. Achieving HbA1c < 7% is still the optimal goal for blood glucose control. This indicates that T2D in Cambodia is not addressed adequately despite the co-existence of the DCIs.

The influence of the ICCC framework on the Cambodian PHC in provision of T2D care to the population could not be observed or captured in this study. The setting with co-existence of care displayed the worst cascade across all bars, while the setting with the hospital-based care had the best cascade among the five. The assumption underlying the ICCC framework that the combined care initiatives of healthcare organisation and community represent an ideal context for the integrated care continuum for T2D [6] and thereby would reduce leakages in the cascade could not be confirmed in this study. Three main reasons could explain this phenomenon. First, the dominant utilisation of healthcare was at private facilities (Chapter 6). Based on the same population-based survey data, among the participants (n=2,360) using healthcare at least once

in the past three months preceding the survey, only 22% utilised the public healthcare. This finding was not surprising. Previous studies in Cambodia also found that people preferred private providers to public providers for outpatient curative care including T2D [7-9]. Nevertheless, inclusion of private providers who are operating largely without sufficient steering and coordination from the government, in the study, was challenging due to a lack of trustworthy information system on this sector [10]. Second, our study design was not able to control for confounding contextual factors embedded in real implementation. It was cross-sectional by nature. We used the OD as a proxy variable to measure the effect of the DCIs, either individually or in co-existence. Our data showed that only four participants (5%, n=78) were seeking T2D care or treatment at the NCD clinic of the referral hospital in the three months preceding the survey in the hospital-based care of OD Samrong, while two participants (3%, n=60) were identified seeking care for T2D at a WHO PEN health center in the health center-based care OD with high coverage of WHO PEN. In the community-based care of OD Kong Pisey, only seven study participants (12% of known T2D identified by the survey, n=58) were people living with T2D connected to the Peer Educator Network, and two were in the co-existence of care of OD Daunkeo (4%, n=51). This indicated that the DCIs under study were not exclusively responsible for the provision of T2D care in each OD, thereby resulting in a weak connection between presence of the DCIs and the cascade results of each study setting. In addition, in the Cambodian health system, the population is not registered to a particular public health facility in the catchment area. They can freely shop around potentially causing patients to use services outside the catchment area of the facility. Third, implementation fidelity of the DCIs (Chapter 8) was also a determining factor [11]. Working mechanisms such as integrated care management across care levels and actors, use of shared disease registries, and coordinated resources for self-management support and community education which are prerequisite to the integrated care based on the ICCC framework [6, 12] were not present.

The in-depth analysis of implementation of the DCIs (Chapter 8) showed that the three DCIs, either individually or in co-existence, had low implementation scores (1 or 2 out of 5) in all the selected settings. OD with hospital-based care scored the lowest, while OD with co-existence of care had better scores in the six care components, suggesting a need for the co-existence of care. The presence of the WHO PEN was observed to contribute noticeably toward early detection and diagnosis (ICP1) and minimally toward treatment in primary care services (ICP2). With the WHO PEN, health centers received one-time support from the national level, making them fulfilling some of the activities of T2D services stipulated in the MPA for health centers [13]. The WHO PEN emphasised and reinforced the screening activity for T2D at health centers, especially in the population aged 40 and over, but diagnosis and initial treatment still have to be made at the referral hospital. Initiation of T2D treatment at health centers is still restricted [1] as health centers are mostly operated by nurses and midwives who are not adequately informed about T2D treatment in their formal education. Hence, the Central Medical Store, a governmental institution responsible for storing and dispensing medical equipment and drugs, cautiously supplied anti-diabetic medicines to health centers. Despite the national standard operating procedure allowing the health centers with the WHO PEN to refill prescriptions for stable cases

of T2D [1], unavailability and inadequacy of anti-diabetic medicines at the health centers were widely evidenced. Peer educator networks in ODs with either community-based care or co-existence of care were likely to increase scores for structured collaboration (ICP5). From the community side, the peer educators have the potential to play a complementary role filling in the gaps in T2D service provision, as also evidenced in other studies [14, 15]. A considerable number of systematic reviews in other countries have found that peers can effectively provide self-management support to patients as they share similar experience, knowledge, and other characteristics to the patients [16, 17]. Likewise, lay people (such as the village health support group) who are not necessarily patients themselves can also provide effective self-management support to patients [18-22]. Community health workers, either peer educators or village health support group, need to be equipped with necessary software (knowledge and skills) and hardware (medical equipment and supplies), and motivated to provide complementary care to that of the healthcare workers in order to support government plans to strengthen the PHC [6, 23]. However, the peer educator network was not formalised in the public healthcare system and mainly received support from the non-governmental organisation. Regarding the organisation of care (ICP6), peer educator network's database was observed in the OD with community-based care to be a crucial local health information system for the continuity of care. No DCI under this study seemed to make a noticeable contribution to health education and counselling (ICP3) and self-management support (ICP4) to people with T2D to improve their adherence to medications and recommended lifestyle.

The co-existence of care, despite having better scores due to the combined contributions, it did not automatically generate synergism necessary for the optimum integrated care for T2D. The three DCIs were not implemented in an integrated way as intended in the national standard operating procedure for management of T2D and hypertension in primary care [1] but rather in isolation with limited interaction between them. Working mechanisms facilitating the integrated care for T2D in terms of shared necessary information and coordinated resources [12] were not observed. There was no proper system for following-up patients for the continuity of care – the peer educator network in the OD with co-existence of care was not functioning optimally after being handed over to the local authority for governance. The referral system between the communities, health centers, and referral hospitals was dysfunctional. The patient record was still paper-based and the form was usually filled with insufficient information. At the NCD clinic of the RH, there was use of a database, but there was ineffective and inefficient use of it in connection to other public health facilities at different levels of care. The peer educators did not work closely with the village health support group or even the health centers. With insufficient resources, capacity and commitment, management teams at the OD and the provincial health department levels could not provide regular supervision and support for the implementation. The co-existence of the three DCIs is not enough. It is necessary to have good implementation fidelity and coordination among them, and health centers under OD leadership could play a crucial role.

Health centers which are supposed to play a coordinating role across the care levels in each OD [1] and represent primary care facilities, the emphasised first level of care in the WHO PEN [24] and the ICCC framework [6], have not been given enough support to play their role in provision of the integrated care for T2D in Cambodia. Based on the analysis of secondary data (Chapter 7), only one in five health centers reported providing the T2D services. The analysis showed that only 25% of 261 health centers reporting with anti-diabetic medicines had sufficient medicines. A study examining health system-level factors in other countries showed that effective care for T2D was hampered by limited access to health services and medications in the primary care level [25]. In Bangladesh, the T2D services in the primary care level was low, especially, in the rural public health facilities. Medicines and equipment for diagnostic testing were largely reported as unavailable [26]. In Myanmar, similar issue of unavailability or inadequacy of essential medicines was also experienced in implementation of the WHO PEN [27]. A study in Tanzania found that the availability of the T2D services was more in private healthcare facilities [28], which was also similarly found in this study in Cambodia. The lack of attention to support provision of T2D care at health centers has been closely linked to the T2D-related policy context in Cambodia.

T2D-related policy context

Before 2000, T2D care was just one of health services in an outpatient department of a referral hospital. One notable hospital providing this hospital-based T2D care was Sihanouk Hospital Center of Hope which is situated in the Capital Phnom Penh and had been operated by a non-governmental organisation more than 20 years since 1996 [29]. In 2002, Médecins Sans Frontières (or Doctors Without Borders) in collaboration with the Ministry of Health established hospital-based chronic disease clinics for people living with T2D and/or hypertension and those with HIV in two referral hospitals in rural settings [30]. The hospital-based care gained more momentum since 2007 when the Ministry of Health opened five T2D clinics at five provincial referral hospitals with support from the World Diabetes Foundation and expansion in coverage has taken place until now – 67 clinics are operating T2D services in 67 (out of 120) referral hospitals [31].

In 2005, MoPoTsyo established a community-based care for T2D in a slum area in the Capital. This is a community-based care initiative in which peer educators – living with T2D themselves – are trained by the organisation to provide health education and self-management support to people with T2D and/or hypertension in their networks. With progressive expansion in coverage, in 2022, the organisation had their networks in 21 out of 103 ODs [32].

In 2015, the Ministry of Health in collaboration with the WHO piloted the WHO PEN interventions in four health centers [33]. This health center-based care for T2D has been rolled out gradually through funding from Cambodia Health Equity and Quality Improvement Project (H-EQIP) starting from 2016 – designed to improve access to quality health services at public health facilities [34]. H-EQIP (Phase I) received pooled funds from the World Bank in the form of both loan and grant and was managed by the Ministry of Health. Up to date (in 2023), 252 (out of

1,269) health centers were implementing the WHO PEN [31]. **Figure 6** maps the main three DCIs and other relevant stakeholders in T2D care.

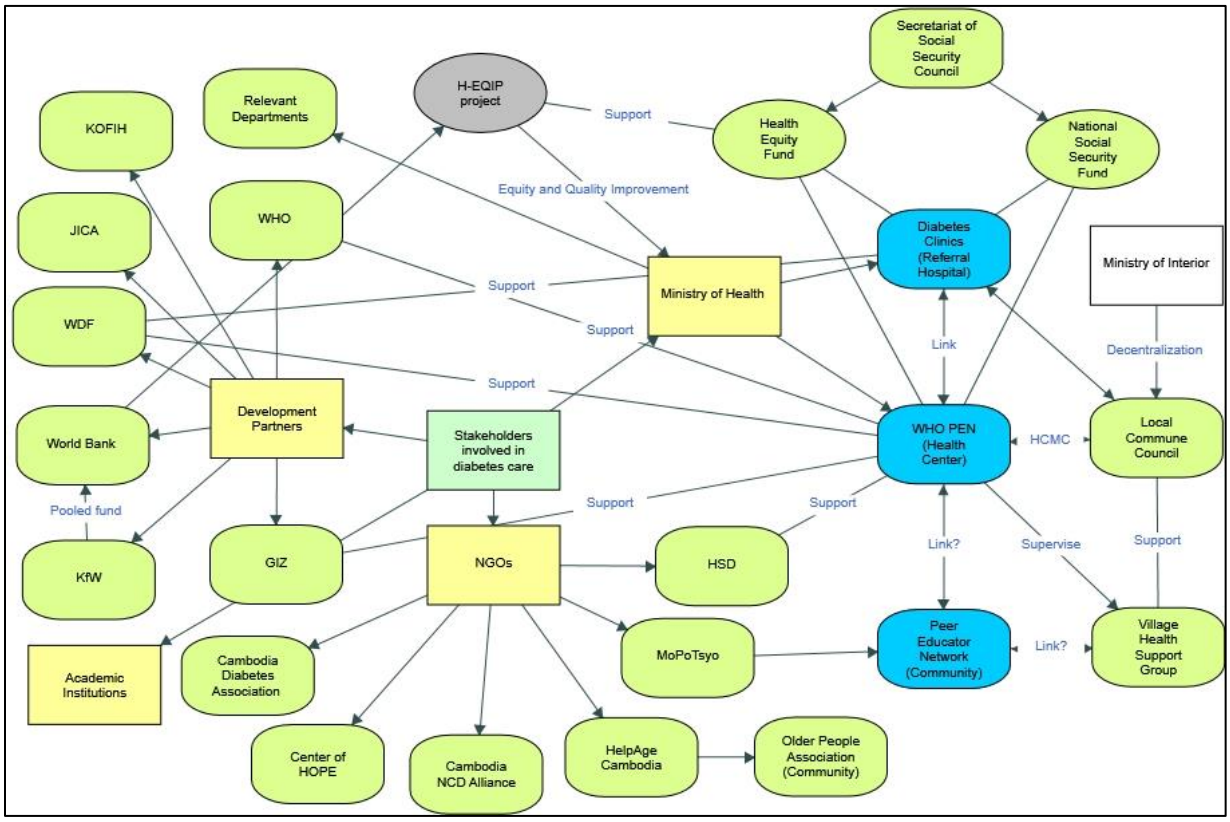

Figure 6. Stakeholder mapping of T2D care in Cambodia

GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit (German Development Partner)
HCMC: Health Center Management Committee
HSD: Health and Social Development
JICA: Japan International Cooperation Agency
KOFIH: Korea Foundation for International Healthcare
KfW: German Development Bank
NGOs: Non-governmental organisations
WDF: World Diabetes Foundation
WHO: World Health Organisation

Figure 7 shows timeline of major events related to DCIs in Cambodia. The three DCIs – hospital-based care, community-based care, and health center-based– are being scaled up and mentioned in a number of national health policy documents [1, 35-38]. However, T2D services in the primary care level is still limited.

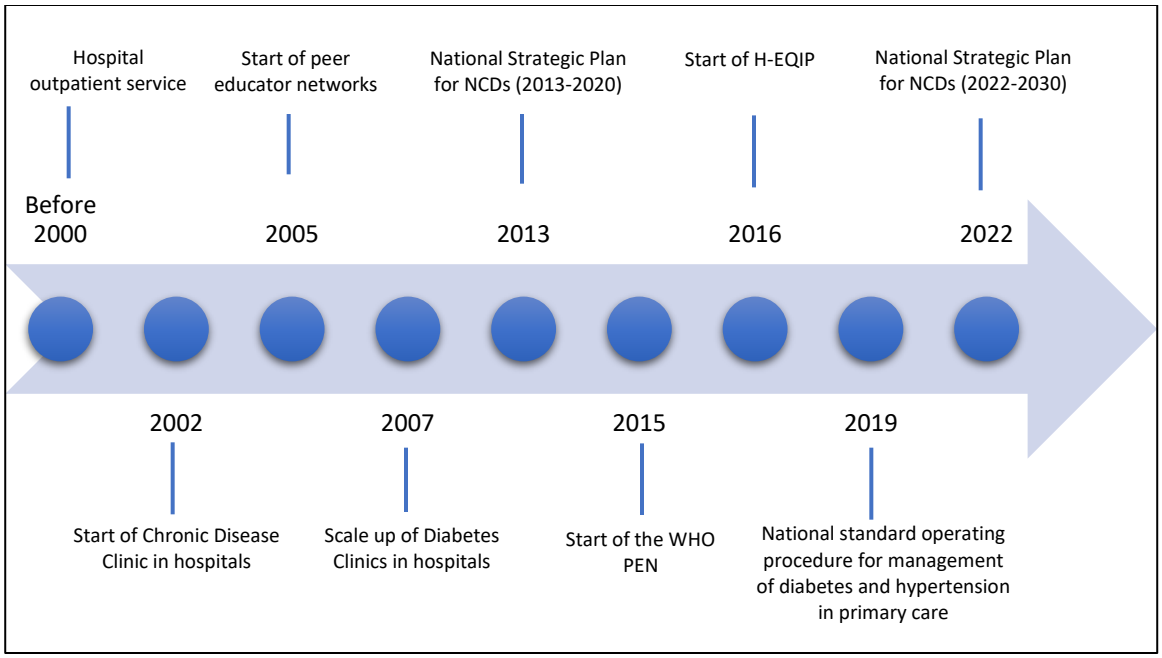

Figure 7. Timeline of major events of DCIs

With the increased burden of T2D and responses to global policies, the Royal Government of Cambodia through the Ministry of Health have developed important policy instruments to guide implementation of management of NCDs including T2D in the Cambodian PHC. With the policy instruments as normative strategic plans, funding from both the government and development partners (though still minimal) has been raised to scale up DCIs in the PHC in a top-down manner with priority given first to the hospital level and then health center level. Apart from this government-managed project, other non-governmental organisations or development partners have separately funded either implementation or research projects in their target ODs usually for a short-term period. The community-based care is still largely reliant on non-governmental organisations, with minimal government ownership on community health workers [39]. We found that the traditional hierarchy in which physicians were central and other healthcare workers played a minor role was still applied (Chapter 8).

In spite of efforts made by the government to include T2D care in policy documents [1, 35-38], T2D responses have not been able to catch the increased burden of the disease, and progress made has not been yet at a steady pace. Nevertheless, a number of policies or national projects were found to be enablers at the macro-level to T2D implementation: (1) health financing arrangements and (2) decentralisation of health services to sub-national authorities.

First, the government has supported health financing arrangements to enhance service quality of supply side and increase access from demand side. From the supply side, the H-EQIP (Phase I) supported strengthening general health delivery in public health facilities through a service delivery grant scheme in which one part was used to support service operations and another part

to incentivise healthcare staff based on performance. We found that healthcare staff prepared their facilities for quarterly assessments in order to get the optimum service delivery grant (Chapter 8). Public health facilities are allowed to accept user fee and use 39% of the collected fee to address service operation problems such as shortage of medicines and 60% to incentivise staff. Another 1% is given to the national treasury. The fees have to be decided with engagement of community and local authority based on the values and principles of rights and equity to health for all through regular meetings of the Health Center Management Committee (HCMC). The committee consists of members from the respective health center, commune council, and village health support group. It is an inter-ministerial committee with the aim to improve the service availability and quality at the health center. The government is also working to gradually expand social health protection schemes. One is for the very poor and vulnerable population – the Health Equity Fund (HEF) which supports the target population through financing user fee exemptions and other related care seeking expenditures [40]. We discovered that people with T2D and/or hypertension benefited from the HEF in terms of reduction in healthcare expenditure (Chapter 6). A big part of the H-EQIP (Phase 1) supported the HEF, and the H-EQIP (Phase 2) is underway with purposes to strengthen local health governance and further improve quality and sustainability of the PHC [41]. Another social health protection scheme is National Social Security Funds (NSSF) covering subgroups of population (i.e. civil servants, employees, and others) [42].

Second, from January 2020, health management functions and service provision have been decentralised to sub-national authorities [43]. Provincial-municipal administrations have directive power over health service management related to human resources, financial resources, and other properties. The decentralisation has the potential for increasing local ownership, but there are also constraints. One is related to management capacity of the provincial-municipal administration on implementation. Past experience on a pilot of granting ODs semi-autonomous status to deliver health services showed that implementation was delayed or interrupted due to inadequate rules and instructions for utilising available resources in an efficient and effective way [44].

A reflection about the application of the ICCC framework in Cambodia

The ICCC framework is not a model for chronic care but serves as a roadmap for health system transformation toward care for chronic conditions, which is also applicable in LMICs. Based on this framework, we can see that in Cambodia effort has been put from the central government in the meso-level on the healthcare organisation, leaving the community to be supported by non-governmental organisations and local health authorities. In the policy environment (macro-level), developed policies are more favourable to the healthcare organisation (referral hospitals and health centers) but not the community. This was also evidenced in our review of T2D care components effectively implemented in the ASEAN health systems (Chapter 3). More care components were identified in the meso-level of healthcare organisation with focuses on: (1) use of information systems, (2) support for self-management and prevention, (3) organisation of healthcare teams, and (4) promotion of continuity and coordination. Only one care component

was repeatedly found in the meso-level of community, that is, provision of complementary services. The review also found that a multidisciplinary healthcare team including pharmacists and nurses has been reported to effectively support patients in self-management of their conditions, with increasing usage of digital health interventions. Community health workers either peer educators or lay people—with necessary support—can provide complementary care to that of the healthcare staff.

In the decentralisation process in Cambodia, community health workers are supposed to be under supervision of health centers which are now part of the sub-national authorities in terms of human resources and finances [43]. Therefore, it will take time for the health centers to be strengthened first before the community health workers could reap the benefits later. In the ICCC framework, community is as equally important as healthcare organisation [6] and has been emphasised for management of NCDs in the PHC too [23]. Making health services closer to the community is one of the main principles of the PHC [45] and one of the main goals of the decentralisation process [43]; therefore, supporting the community health workers should be given more attention.

According to the ICCC framework, the three DCIs are relevant for expanding T2D services in the Cambodian PHC. They have been adopted for the scale up as indicated in the national policies and perceived by interviewed stakeholders to potentially contribute to strengthening the PHC on T2D services. Nevertheless, the three DCIs have not been implemented in an integrated way to produce intended outcomes. The fact that health centers do not have capacity to confirm the diagnosis and initiate treatment for T2D made the implementation less comfortable and convenient for the population. Consequently, people might bypass health centers and prefer to utilise referral hospitals or nearby private providers directly. If the screened people could not have access to the diagnosis procedure at referral hospitals by some reasons, the chance of not receiving prompt care or treatment would increase.

The three DCIs are not yet fully feasible at the health center and community levels due to current limitations in competence of human resources, adequacy of medicines, and robustness of health information system. This has put sustainability of their implementation in question. Our in-depth analysis of the implementation found that at some WHO PEN health centers when the equipment and materials were out of order or stock, related activities were usually halted. They mainly relied on support from the central level which was further dependent on availability of funding. In the OD with the co-existence of care, the peer educator network became dysfunctional after being handed over to the local health authority for governance.

Limitations

This PhD project evaluated the performance of three main DCIs (hospital-based, health center-based, and community-based) being scaled up and implemented in the Cambodian PHC in a comprehensive manner. The strength of this study is the triangulation of evidence obtained from multiple sources of data (quantitative and qualitative) from multi-levels of the health system and

large geographical spread in the country. However, there were two main limitations. First, the study design of selecting ODs to represent the DCIs either individually or in co-existence masked potential confounding contextual factors. We could not use the OD as a proxy variable to measure the effect of the DCI. The DCIs, either individually or in co-existence, were not exclusively responsible for the provision of T2D care in each OD; thereby, the cascade results obtained from the population-based survey could not be exclusively attributed to the performance of the DCIs. The dominant use of private services, which could not be incorporated in the study design due to the lack of trustworthy information system in this sector, and the fact that the population is not confined to a particular public health facility in the catchment area are the main confounding factors. This cross-sectional survey, of course, could show a snapshot of effective coverage of the DCIs but was not conducive to determination of causal pathways leading to T2D care outcomes in relation to the DCIs. A valid link between the cascade results and implementation results of the DCIs in each OD could not be established. Second, the sample size of the population-based survey was not large enough to yield a sufficiently large number of T2D patients to enable us to assess determinants of the last three bars (the In care bar, the In treatment bar, and the Under control bar).

Considerations to overcome these two limitations could be a longitudinal study design with collection of routine cohort data in each DCI at the facility level (if available and reliable). This design would enable us to evaluate the effectiveness of each DCI over time with adaptation to change more directly and precisely. There are contextual complexities in the health systems, especially at the implementation level. Selection of study settings or health facilities should be done after the complexities are carefully examined. There is disparity between a theoretical framework and real implementation which is much influenced by individual context. This disparity has to be seriously taken into account in conducting implementation research. For instance, the existence of care services does not directly translate into utilisation of the services. Co-existence of the three DCIs does not automatically create integration and synergism and consequently improve care performance.

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Chapter 10: Conclusions

This PhD study shows that the performance of DCIs in the Cambodian public healthcare system in providing the T2D care continuum remains limited, although needs for care are increasing. T2D is asymptomatic, incurable, and chronic, with progressive nature toward health complications. The care should be proactive, patient-centered, and community-based. It has to be integrated across care levels and actors involved in the care provision and sustainable for long-term continuity of care. The integrated care for T2D in the PHC of the OD health system has potential contributions to achievement of health Sustainable Development Goals and universal health coverage for T2D care by 2030. Based on the findings, a multidisciplinary healthcare team including pharmacists and nurses should be adopted to support patients in self-management of their T2D conditions. Community health workers including peer educators or other trained health volunteers such as village health support groups should support the healthcare team to provide health education and self-management support to people with T2D and communities. They can be equipped to play a role as care coordinators to improve structured collaboration and organisation of care. Therefore, it is vital that all relevant community health workers are formalised and financially supported. Health centers (primary care level) should be strengthened as a locus for the provision of care continuity for T2D in the public healthcare system since healthcare utilisation at public health facilities was found to significantly reduce healthcare expenditure among T2D patients. Thus, further research should explore factors enabling the health centers to provide working mechanism for the DCIs to be implemented in an integrated manner according to the ICCC framework.

Policy implications

Based on the findings of this PhD study, we would like to offer a policy implication to strengthen the role and capacity of health centers (primary care facilities) to improve the continuum of care for T2D in Cambodia with both medium-term and long-term strategies by different levels of the ICCC framework.

Policy environment

Medium-term strategies

- Updating the MPA or relevant guidelines to allow diagnosis and initiation of treatment for stable T2D cases at health centers
- Providing in-service training with certified licence as diabetes educators for nurses at health centers
- Making anti-diabetes medicines as essential drugs at health centers
- Facilitating the decentralisation process
- Capitalising on the H-EQIP benefits

Long-term strategies:

- Upgrading the pre-service education for nurses to have necessary competencies in making diagnosis and initiating treatment for stable T2D cases
- Expanding the use of digital technologies to support coordination for the continuity of care across care levels and actors through electronic medical records of individual patients
- Expanding coverages of HEF and NSSF which include T2D-related services
- Formalising all relevant community health workers with financial support

Healthcare Organisation

Medium-term strategies

- Improving digital literacy among health center staff for case management
- Allocating some budget to train and incentivise the formalised relevant community health workers for referring and following up cases
- Re-investing the user fee (39%) to support T2D services at the health center

Long-term strategies

- Improving leadership and management skills among health center staff
- Promoting a multidisciplinary, inclusive, collaborative, and complementary team in which healthcare workers with special training in T2D (such as diabetes educators) take the lead
- Building good rapport with the commune council

Community

Medium-term strategies

- Raising awareness of T2D burden through the formalised relevant community health workers and the respective HCMC
- Supporting the respective health center to provide information about care and self-management support through the formalised relevant community health workers

Long-term strategies

- Improving leadership and management skills among commune leaders
- Allocating health-related budget of the commune council to support provision of T2D services at the respective health center and community health workers

Annexes

Annex 1. The ICCC building blocks and care components

Micro-level: Patient Interaction level	
Care Component	**Construct**
1. Prepared, informed, and motivated patients and families	• Be informed about their diabetes conditions, including the expected course, expected complications, and effective strategies to prevent complications and manage symptoms • Be motivated to change and maintain daily health behaviours, adhere to long-term therapies, and self-manage their conditions • Be prepared with behavioural skills to manage their conditions at home--including having the necessary medications and medical equipment, self-monitoring tools, and self-management skills
2. Prepared, informed, and motivated health care teams	• Team members accept roles and responsibilities for tasks according to their professional strengths and capacities • Teams form according to human resource and geographic realities of the health care organisation
3. Prepared, informed, and motivated community partners	• Equipped with information and skills about the management of diabetes • Prepared to take on functions traditionally assigned to health care workers in a public health system
Meso level: Health care organisation	
4. Promote continuity and coordination	• Health care workers who care for the same patients communicate with each other across levels of care (primary, secondary, and tertiary) • Care is planned and thoughtful over the course of the condition • Follow-up visits are scheduled and organisations are proactive in caring for patients

5. Encourage quality of care through leadership and incentives	• Senior and other influential leaders lend clear support and sponsorship for improving the care in their health care organisations • Incentive or reward system is established for administrators, health care workers, and patients and for effective clinical processes that affect management and prevention • There are ongoing quality monitoring and quality improvement projects which become routine activities among all health care workers • Health care leaders play a pivotal role in creating an environment that values quality
6. Organize and equip health care teams	• Health care teams have necessary supplies, medical equipment, laboratory access, and essential medications to provide care that is informed by scientific evidence • Health care teams have support to make optimal decisions, including written guidelines of care, and diagnostic and treatment algorithms • Health care teams have special skills and knowledge that extend traditional biomedical training • Health care teams have effective communication abilities to promote information exchange, open questioning, and shared decision-making with patients • Health care teams have expertise in behavioural interventions to help patients initiate new self-management techniques, adhere to complex regimens, and make lifestyle changes • Health care teams have skills to support patients in their efforts to maintain change over the long-term course of the condition • Health care teams are made up of multiple health care workers to work cooperatively and share patient responsibilities
7. Support self-management and prevention	• Health care teams receive and provide self-management training and educate patients and families (for example, to improve adherence to medications, consistent exercise, proper nutrition, regular sleep, and tobacco cessation) • Attention to self-management and prevention of chronic conditions occur at every patient encounter
8. Use information systems	• Timely information system about individual patients or populations (patient registry) to identify patients' needs, to follow-up and plan care, to monitor responses to

	treatment, to assess health outcomes, or to support a reminder function, etc. • Data about epidemiology, treatment, and health care outcomes are gathered and organized
Meso-level: Community	
9. Raise awareness and reduce stigma	• Leaders of local communities and relevant organisations raise awareness about diabetes conditions and their associated risk factors • Leaders in the community lobby their political counterparts to enhance support for chronic care conditions including diabetes
10. Encourage better outcome through leadership and support	• There are community development/health boards or village development groups that can advocate for better health care and explore the best strategies to support fellow community members who are living with long-term problems • All leaders in communities are influential in aligning their policies and practices with the main objectives of optimal chronic conditions care including diabetes
11. Mobilize and coordinate resources	• Communities raise funds and identify financing schemes that generate resources to support screening, prevention, and improved management of chronic conditions including diabetes
12. Provide complementary services	• There are local and international NGOs providing complementary preventive and management services for a given community, along with the participation of the community members • There is an informal network of providers, such as community health workers and volunteers who provide basic services for patients with chronic conditions including diabetes (education about risks and self-management) • Community organisations fill the gaps in services for patients with chronic problems including diabetes that are not provided in health care organisations
Macro-level: A positive policy environment	
13. Provide leadership and advocacy	• Decision makers are sensitized and informed about the rising burden of diabetes, and the existence of effective strategies and models for managing them

	• There are credible spokespersons recruited to share the message about diabetes and increase awareness among policy-makers, health care leaders, health care workers, the general community, patients, and families • There are effective media campaigns on diabetes
14. Integrate policies	• There are policies encompassing prevention, promotion, and control strategies • There are explicit links to other governmental programmes and community-based organisations
15. Promote consistent financing	• Financing decisions are based on principles of equity and effectiveness • Financing is consistent across all divisions of the health care system and integrated across levels of care and care settings such as primary health care and hospital-based care • Financing is structured so that resources can be maintained over time
16. Develop and allocate human resources	• Upgrade of training curriculum for health care professionals to meet the needs • Continuing education for health care workers is emphasized • Incentives and quotas are adopted to attract and create an optimal mix of health care professionals needed to meet the demands
17. Support legislative framework	• There is support for development or adoption of legislation and regulations that can reduce the burden of chronic conditions
18. Strengthen partnership	• There is focus on strong partnerships among government sectors, non-government health sectors, private health care providers, charities, local government, or community entities (religious groups, schools, and employers)

Source: World Health Organisation. Innovative care of chronic conditions: building blocks for action. Geneva: World Health Organisation; 2002. https://apps.who.int/iris/handle/10665/42500.

Annex 2. Summary of key findings of the umbrella review of systematic reviews and/or meta-analyses, categorised by intervention or strategy

Intervention/Strategy	Key findings
1. Digital health interventions (telemedicine, smartphone-based application, mobile phone text messages)	• Telemedicine-based interventions (particularly, teleconsultation strategy) were effective in improving serum levels of HbA1c and fasting blood sugar, adherence to treatment and self-efficacy. • Mobile phone text messages helped patients (especially middle-aged patients) improve medication adherence and reduce non-attendance rates. • Digital education seemed to improve knowledge and skills scores in health care professionals compared with traditional or usual education.
2. Pharmacist-based interventions	• Pharmacists' interventions as part of the patient's health care team improved the care of diabetes patients by significantly improving clinical outcomes, medication adherence, and patients' health-related quality of life. • Pharmacist services may reduce health service utilisation such as visits to general practitioners and hospitalisation rates. • Pharmacists co-located in primary care general practice clinics delivered a variety of interventions with favourable results seen in the management of cardiovascular disease, diabetes and some measures of quality use of medicines.
3. Peer-led interventions	• Peer support intervention (with moderate or high frequency of contact) was effective and produced clinically and statistically significant reduction in HbA1c and systolic blood pressure levels.
4. Community-based self-care interventions	• Self-care interventions in community settings made improvements in biophysical outcomes.
5. Group-based diabetes self-management education interventions (either by health care professionals or community health workers)	• Group-based self-management interventions delivered by trained diabetes educators or laypersons produced significant effects on improvement of HbA1c level, self-efficacy, and frequency of emergency visits and were an economically efficient approach for communities and healthcare systems.
6. Task-shifting	• Task-shifting performed by non-physician healthcare workers was potentially cost-effective and clinically effective for the

	screening and management of non-communicable diseases including diabetes. • Non-medical prescribers (pharmacists and nurses) were as effective as usual care medical prescribers and could deliver comparable outcomes for systolic blood pressure, HbA1c, low-density lipoprotein, medication adherence, patient satisfaction, and health-related quality of life.
7. Integration	• Integrating diabetes with HIV services was feasible, with dedicated clinical pharmacists playing a role. • Integration should build on existing protocols and use the community as a locus for advocacy and health services, while promoting a multidisciplinary team.
8. Role of hospitals in the downstream coordination and follow-up care	• Specialised care settings at hospitals could play a leading role in transitional care interventions and the coordination of chronic care with primary care with better outcomes for the patients. • The patient experiences were positively influenced by the coordinating role of a specialist.
9. Screening	• Targeted screening appeared to be cost-effective compared to universal screening. • For optimal cost-effectiveness, screening for both type 2 diabetes and prediabetes should be initiated around age 45-50, with repeated testing every 5 years.

Annex 3. Questionnaire about eligible individual information

INFORMED CONSENT

INTRO:

Hello, my name is ____and I am from the National Institute of Public Health. You has been randomly selected to participate in this study [on the scaling up of diabetes and hypertension in Cambodia] based on information from your household. The information you give will be kept confidential and no personal details will appear in any record. This interview will take approximately 60 minutes. You do not have to answer any question you don't want to and you can stop the interview at any time. We will also measure your blood pressure, weight and height, waist and hip circumferences and your fasting blood glucose (FBG) [and HbA1c and Creatinine level for known diabetes and those having FBG ≥ 126 mg/dl]. We very much appreciate your participation and information.

ELIGIBILITY AND RECRUITMENT CHECK

Q1. Are you a usual member of the household who have stayed in the household the night before the interview or had not been absent for more than 6 months?

[1] Yes
[0] No **(Stop the interview)**

Q2. Are you 40 or above?

[1] Yes
[0] No **(Stop the interview)**

Q3. Are you physically and mentally capable to answer the questions?

[1] Yes
[0] No **(Stop the interview)**

Q4. Are you willing to take part in the study?

[1] Yes
[0] No **(Stop the interview)**

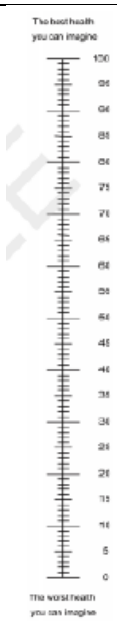
SECTION 1: SOCIO-DEMOGRAPHIC INFORMATION

Q.N	Description & questions	Response
Q5	How old are you? *-Record in years as stated by the participant* *-Record 99 if don't know*	_____Years
Q6	Sex of participant *Record sex of the participant as observed*	1 = Male 2 = Female
Q7	What is your marital status? *-Record 88 if refuse to answer*	1=Married or living together 2=Divorced or separated 3=Widowed 4=Never married and never lived together
Q8	What is your highest educational level? *Record 99 if don't know*	1=No formal schooling 2=Less than primary school 3=Primary school 4=Secondary school 5=High school 6=College/University 7=Post graduate degree
Q9	What is your ethnic group?	1 = Khmer 2 = Vietnamese 3 = Chinese 4 = Cham (Muslim) 5 = Other
Q10	Which of the following best describes your main work status within the past 12 months? *Record 88 if refuse to answer*	1=Household tasks 2=Civil servant 3=Employee of private company/NGO 4=Self-employed farmer 5=Large-scale farmer with employees 6=Self-employed in small business 7=Running a big business with employees 8=Casual worker 9=Working abroad 10=At school (pupil/student) 11=Unemployed or not eligible 12=Retired

Q11	Taking the past year, can you give an estimate of your annual income if I read some options to you? *Record 88 if refuse to answer*	1 = no earnings 2 = less than or 250 USD 3 = more than 251- 1500 USD 4 = more than 1501 – 3500 USD 5 = more than 3501 USD

SECTION 2: HEALTH STATUS AND QUALITY OF LIFE

Q.N	Description and Questions	Response
Q12	At this point of time in your life, how would you describe: Q 12.1. Your home situation [____] Q 12.2. Your family relationships [____] Q 12.3. Your finances [____] Q 12.4. Your work situation [____] *-Record 99 if don't know and 88 if refuse*	1 = Excellent 2 = Very good 3 = Good 4 = Fair 5 = Poor

Q13	How good or bad is your health today? *-The scale is numbered from 0 to 100.* *-100 means the best health you can imagine.* *-0 means the worst health you can imagine.* *-Please mark an X on the scale to indicate how your health is today.* *-Record 99 if don't know and 88 if refuse*	
Q14	Have you ever been told by a doctor or other health worker that you have hypertension? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q15	Have you ever been told by a doctor or other health worker that you have diabetes? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q16	Have you ever been told by a doctor or other health worker that you have heart problems? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q17	Have you ever been told by a doctor or other health worker that you have symptoms suggestive of a stroke? *-Record 99 if don't know/unsure*	0 = No 1 = Yes

Q18	Have you ever been told by a doctor or other health worker that you have chronic kidney disease? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q19	How many natural teeth do you have? *-Record 99 if don't know*	0 = None 1 = 1-9 teeth 2 = 10-19 teeth 3 = 20 teeth or more
Q20	During the past 12 months, did your teeth or mouth cause any pain or comfort? *-Record 99 if don't know*	0 = No 1 = Yes
Q21	Over the last 2 weeks, how often have you been bothered by any of the following problems? Q 21.1. Little interest or pleasure in doing things [____] Q 21.2. Feeling down, depressed, or hopeless. [____] Q 21.3. Trouble falling or staying asleep, or sleeping too much. [____] Q 21.4. Feeling tired or having little energy. [____] Q 21.5. Poor appetite or overeating [____] Q 21.6. Feeling bad about yourself – or that you are a failure or make yourself or down your family [____] Q 21.7. Trouble concentrating on things, such as reading the newspaper or watching television [____] Q 21.8. Moving or speaking so slowly that other people could have noticed? Or the oppositebeing so fidgety or restless that you have been moving around a lot more than usual [____] Q 21.9. Thoughts that you would be better off dead or of hurting yourself in some ways [____]	0 = Not at all 1 = Several days 2 = More than half the days 3 = Nearly everyday

Q22	We would like to confirm that you have: *-This question is for categorizing respondents for the following sections and it is also important to ask respondents to confirm their main conditions in this survey.* *-IF the answer is "0", go to Section 3* *-IF the answer is "1", go to Section 3a* *-IF the answer is "2", go to Section 3b* *-IF the answer is "3", go to Section 3c*	0 = Neither hypertension nor diabetes 1 = Only hypertension 2 = Only diabetes 3 = Both diabetes and hypertension

SECTION 3: HEALTH CARE UTILIZATION

Q.N	Description and Questions	Response
Q23	Have you sought medical treatment or advice as an outpatient from anyone in the past 3 months? *-If No, go to Question 40.*	0 = No 1 = Yes
Q24	Where did you seek medical advice or treatment for illness in the past 3 months? *-More than one answer can be selected.* *-Data collectors can use probes to help respondents determine the types of health facilities in the Response Column.* *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public; specify: 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician

		16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= Other; specify
From Q25-Q39, it is a set of questions that are asked following choices selected in Q24. If 2 or 3 choices were selected in Q24, Q25-Q39 would appear 2 or 3 times, accordingly.		
Q25	How many times did you visit the selected place**(s)** in Q24 in the past three months?	_____ times
Q26	How much in total was spent on the treatment at the selected place(s) in Q24? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels
Q27	How did you pay for the treatment cost at the selected place(s) in Q24? *-Record 99 if don't know and 88 if refuse*	1= Health Equity Fund 2= Voucher 3= Fee Exemption 4= NGO 5= National Social Security Fund 6= Community-Based Health Insurance 7= Health Insurance through Employer 8= Other Privately Purchased Commercial Health Insurance 9= Wage/income 10= Loan/ Ton Tin 11= Sale of Assets 12= Gift from Relative 13= Savings 14= Other
Q28	How much in total was spent on transport to go to and return from the selected place(s) in Q24? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels

Q29	On average how many hours do you spend to get treatment/advices from the selected place(s) in Q24? *-Record 99 if don't know and 88 if refuse*	_____Hours
Q30	How satisfied are you with the effect of your {treatment/care} at the selected place(s) in Q24? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q31	How satisfied are you with the explanations the {doctor/other health professional} has given you about the results of your {treatment/care} at the selected place(s) in Q24? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q32	The {doctor/other health professional} at the selected place(s) in Q24 was very careful to check everything when examining you. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q33	At the selected place(s) in Q24, how satisfied were you with the choices you had in decisions affecting your health care? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither s atisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q34	How much of the time did you feel respected by the {doctor/other health professional} at the selected place(s) in Q24? *-Record 99 if don't know/unsure*	0 = All of the time 1 = Most of the time 2 = About half the time 3 = Some of the time 4 = None of the time

Q35	At the selected place(s) in Q24, the time you had with the {doctor/other health professional} was too short. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q36	Are you satisfied with the care you received in the selected place(s) in Q24? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither s atisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q37	Did you get your blood pressure measured at the selected place(s) in Q24? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q38	Did you get your blood glucose tested at the selected place(s) in Q24? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q39	Would you recommend the selected place(s) in Q24 to others? *-Record 99 if don't know/unsure*	1 = Not recommended 2 = Recommend with reservations 3 = Recommend 4 = Highly recommend
Q40	Have you ever had your blood glucose tested in the last three years? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q41	Have you ever had your blood pressure measured in the last three years? *-Record 99 if don't know/unsure*	0 = No 1 = Yes

SECTION 3a: HEALTH CARE UTILIZATION FOR HYPERTENSION

Q.N	Description and Questions	Response
Q42a	How long have you lived with hypertension? *-Record 99 if don't know/unsure and 88 if refuse* *-Less than a year is rounded up to one year* *-Standard rounded up formula is applied.*	_____Years
Q43a	Where were you first diagnosed as having hypertension? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo
Q44a	Where did you first seek advice or treatment for hypertension after being diagnosed? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR)

		7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify
Q45a	Did you go to other places for follow up treatment/care for your hypertensive conditions? *-Record 88 if refuse* *-If NO, please skip Q46a*	0 = No 1 = Yes
Q46a	If yes to Q46a, where else did you go to get follow up treatment/care for your hypertensive conditions?	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market

		15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
Q47a	Did you get treatment/care for your hypertensive conditions in the past **12 months?** *-Record 88 if refuse* *-If NO, please skip Q48a-63a*	0 = No 1 = Yes
Q48a	Are you currently receiving any of the following treatment/advices for your hypertensive conditions prescribed by a doctor or other health care worker? Q 48.1a. Drugs (medication) that you have taken in the past two weeks [____] Q 48.2a. Advice to reduce salt intake [___] Q 48.3a. Advice or treatment to lose weight [____] Q 48.4a. Advice or treatment to stop smoking [____] Q 48.5a. Advice to start or do more physical exercise [____] Q 48.6a. Advice to stop drinking alcohol [____] *-Record 99 if don't know and 88 if refuse*	0 = No 1= Yes
Q49a	Have you had your blood cholesterol measured in the past 12 months? *-Record 99 if don't know and 88 if refuse*	0 = No 1= Yes
Q50a	Where did you seek medical advice or treatment for your hypertensive condition in **the past 3 months**? *-**More than one answer can be selected**.*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post

	-Data collectors can use probes to help respondents determine the types of health facilities in the Response Column. *-Record 99 if don't know and 88 if refuse*	6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo
From Q51a-Q63a, it is a set of questions that are asked following choices selected in Q51a. If 2 or 3 choices were selected in Q50a, Q51a-Q63a would appear 2 or 3 times, accordingly.		
Q51a	How many times did you visit the selected place**(s)** in Q50a in the past three months?	_____ times
Q52a	How much in total was spent on the treatment at the selected place(s) in Q50a? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels

Q53a	How did you pay for the treatment cost at the selected place(s) in Q50a? *-Record 99 if don't know and 88 if refuse*	1= Health Equity Fund 2= Voucher 3= Fee Exemption 4= NGO 5= National Social Security Fund 6= Community-Based Health Insurance 7= Health Insurance through Employer 8= Other Privately Purchased Commercial Health Insurance 9= Wage/income 10= Loan/ Ton Tin 11= Sale of Assets 12= Gift from Relative 13= Savings 14= Other
Q54a	How much in total was spent on transport to go to and return from the selected place(s) in Q50a? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels
Q55a	On average how many hours do you spend to get treatment/advices from the selected place(s) in Q50a? *-Record 99 if don't know and 88 if refuse*	_____Hours
Q56a	How satisfied are you with the effect of your {treatment/care} at the selected place(s) in Q50a? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q57a	How satisfied are you with the explanations the {doctor/other health professional} has given you about the results of your {treatment/care} at the selected place(s) in Q50a? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very d issatisfied

Q58a	The {doctor/other health professional} at the selected place(s) in Q50a was very careful to check everything when examining you. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q59a	At the selected place(s) in Q50a, how satisfied were you with the choices you had in decisions affecting your health care? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither s atisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q60a	How much of the time did you feel respected by the {doctor/other health professional} at the selected place(s) in Q50a? *-Record 99 if don't know/unsure*	0 = All of the time 1 = Most of the time 2 = About half the time 3 = Some of the time 4 = None of the time
Q61a	At the selected place(s) in Q50a, the time you had with the {doctor/other health professional} was too short. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q62a	Are you satisfied with the care you received in the selected place(s) in Q50a? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither s atisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied

Q63a	Would you recommend the selected place(s) in Q50a to others? *-Record 99 if don't know/unsure*	1 = Not recommend 2 = Recommend with reservations 3 = Recommend 4 = Highly recommend
Q64a	Have you ever been told by a doctor that you have eyes problems? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q65a	Have you ever been told by a doctor that you have kidney problems? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q66a	Have you ever been told by a doctor that you have lost the sensation of your peripheral membrane, such as foot, hand, arm? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q67a	In **the past 3 months**, besides seeking medical advice or treatment for your hypertensive condition, have you sought medical treatment or advice for other illnesses or conditions? If No, go to Section 4. If Yes, go to Q24-Q39	0 = No 1 = Yes

SECTION 3b: HEALTH CARE UTILIZATION FOR DIABETES

Q.N	Description and Questions	Response
Q42b	How long have you lived with diabetes? *-Record 99 if don't know/unsure and 88 if refuse* *-Less than a year is rounded up to one year* *-Standard rounded up formula is applied.*	_____Years

Q43b	Where were you first diagnosed as having diabetes? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
Q44b	Where did you first seek advice or treatment for diabetes after being diagnosed? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical

		14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
Q45b	Did you go to other places for follow up treatment/care for your diabetes conditions? *-Record 88 if refuse* *-If NO, please skip Q46b*	0 = No 1 = Yes
Q46b	If yes to Q45b, where else did you go to get follow up treatment/care for your diabetes conditions?	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:

Q47b	Did you get treatment/care for your diabetes conditions in the past 12 months? *-Record 88 if refuse* *-If NO, please skip Q48b-64b*	0 = No 1 = Yes
Q48b	Are you currently receiving any of the following treatment/advices for your diabetes conditions prescribed by a doctor or other health care worker? Q. 48b.1. Insulin [____] Q. 48b.2. Drugs (medication) that you have taken in the past two weeks [____] Q. 48b.3. Special prescribed diet [____] Q. 48b.4. Advice or treatment to lose weight [____] Q. 48b.5. Advice or treatment to stop smoking Q. 48b.6. Advice to start or do more physical exercise Q. 48b.7.Advice to stop drinking alcohol [____]	0 = No 1= Yes
Q49b	Have you had your blood glucose measured in the past 12 months? *-Record 99 if don't know and 88 if refuse*	0 = No 1= Yes
Q50b	Have you had your HbA1c tested in the past 12 months? *-Record 99 if don't know and 88 if refuse*	0 = No 1= Yes
Q51b	Where did you seek medical advice or treatment for illness in the **past 3 months**? ***-More than one answer can be selected.*** *-Data collectors can use probes to help respondents determine the types of health facilities in the Response Column.* *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy

		11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
From Q52b-Q64b, it is a set of questions that are asked following choices selected in Q51b. If 2 or 3 choices were selected in Q51b, Q52b-Q64b would appear 2 or 3 times, accordingly.		
Q52b	How many times did you visit the selected place**(s)** in Q51b in the past three months?	_____ times
Q53b	How much in total was spent on the treatment at the selected place(s) in Q51b? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels OR _____ USD
Q54b	How did you pay for the treatment cost at the selected place(s) in Q51b? *-Record 99 if don't know and 88 if refuse*	1= Health Equity Fund 2= Voucher 3= Fee Exemption 4= NGO 5= National Social Security Fund 6= Community-Based Health Insurance 7= Health Insurance through Employer 8= Other Privately Purchased Commercial Health Insurance 9= Wage/income 10= Loan/ Ton Tin 11= Sale of Assets 12= Gift from Relative

		13= Savings 14= Other
Q55b	How much in total was spent on transport to go to and return from the selected place(s) in Q51b? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels OR _____ USD
Q56b	On average how many hours do you spend to get treatment/advices from the selected place(s) in Q51b? *-Record 99 if don't know and 88 if refuse*	_____Hours
Q57b	How satisfied are you with the effect of your {treatment/care} at the selected place(s) in Q51b? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q58b	How satisfied are you with the explanations the {doctor/other health professional} has given you about the results of your {treatment/care} at the selected place(s) in Q51b? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q59b	The {doctor/other health professional} at the selected place(s) in Q51b was very careful to check everything when examining you. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q60b	At the selected place(s) in Q51b, how satisfied were you with the choices you had in decisions affecting your health care? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied

Q61b	How much of the time did you feel respected by the {doctor/other health professional} at the selected place(s) in Q51b? *-Record 99 if don't know/unsure*	0 = All of the time 1 = Most of the time 2 = About half the time 3 = Some of the time 4 = None of the time
Q62b	At the selected place(s) in Q51b, the time you had with the {doctor/other health professional} was too short. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q63b	Are you satisfied with the care you received in the selected place(s) in Q51b? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q64b	Would you recommend the selected place(s) in Q51b to others? *-Record 99 if don't know/unsure*	1 = Not recommended 2 = Recommend with reservations 3 = Recommend 4 = Highly recommend
Q65b	Have you ever been told by a doctor that you have eyes problems? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q66b	Have you ever been told by a doctor that you have kidney problems? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q67b	Have you ever been told by a doctor that you have lost the sensation of your peripheral membrane, such as foot, hand, arm? *-Record 99 if don't know/unsure*	0 = No 1 = Yes

Q68b	In **the past 3 months**, besides seeking medical advice or treatment for your diabetes condition, have you sought medical treatment or advice for other illnesses or conditions? If No, go to Section 4. If Yes, go to Q24-Q39	0 = No 1 = Yes

SECTION 3c: HEALTH CARE UTILIZATION FOR DIABETES AND HYPERTENSION

Q.N	Description and Questions	Response
Q42c	How long have you lived with diabetes? *-Record 99 if don't know/unsure and 88 if refuse* *-Less than a year is rounded up to one year* *-Standard rounded up formula is applied.*	_____Years
Q43c	Where were you first diagnosed as having diabetes? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant

		18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
Q44c	Where did you first seek advice or treatment for diabetes after being diagnosed? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
Q45c	How long have you lived with hypertension? *-Record 99 if don't know/unsure and 88 if refuse* *-Less than a year is rounded up to one year* *-Standard rounded up formula is applied.*	_____Years

Q46c	Where were you first diagnosed as having hypertension? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
Q47c	Where did you first seek advice or treatment for hypertension after being diagnosed? *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical

		14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
Q48c	Did you go to other places for follow up treatment/care for your hypertensive and diabetes conditions? *-Record 88 if refuse* *-If NO, please skip Q49c*	0 = No 1 = Yes
Q49c	If yes to Q48c, where else did you go to get follow up treatment/care for both conditions?	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:

Q50c	Did you get treatment/care for both conditions in the past 12 months? *-Record 88 if refuse* *-If NO, please skip Q51c-68c*	0 = No 1 = Yes
Q51c	Are you currently receiving any of the following treatment/advices for both conditions prescribed by a doctor or other health care worker? Q. 51c.1. Insulin [____] Q. 51c.2. Drugs (medication) that you have taken in the past two weeks [____] Q. 51c.3. Special prescribed diet [____] Q. 51c.4. Advice or treatment to lose weight [____] Q. 51c.5. Advice or treatment to stop smoking [____] Q. 51c.6. Advice to reduce salt intake [____] Q. 51c.7. Advice to start or do more physical exercise [____] Q. 51c.8. Advice to stop drinking alcohol [____]	0 = No 1= Yes
Q52c	Have you had your blood glucose measured in the past 12 months? *-Record 99 if don't know and 88 if refuse*	0 = No 1= Yes
Q53c	Have you had your HbA1c tested in the past 12 months? *-Record 99 if don't know and 88 if refuse*	0 = No 1= Yes
Q54c	Have you had your blood cholesterol measured in the past 12 months? *-Record 99 if don't know and 88 if refuse*	0 = No 1= Yes

Q55c	Where did you seek medical advice or treatment for your conditions in **the past 3 months?** -***More than one answer can be selected***. *-Data collectors can use probes to help respondents determine the types of health facilities in the Response Column.* *-Record 99 if don't know and 88 if refuse*	1= National hospital (PP) 2= Provincial hospital (RH) 3= District hospital (RH) 4= Health centre 5= Health post 6= Provincial rehabilitation centre (PRC) or Community-based rehabilitation (CBR) 7= Other public 8= Private hospital 9= Private clinic 10= Private pharmacy 11= Home/Office of trained health worker/nurse 12= Visit of trained health worker/nurse 13= Other private medical 14= Shop selling drugs/market 15= Kru Khmer/ Magician 16= Monk/religious leader 17= Traditional birth attendant 18= Oversee medical service 19= MoPoTsyo 20= Other; specify:
From Q56c-Q68c, it is a set of questions that are asked following choices selected in Q55c. If 2 or 3 choices were selected in Q55c, Q56c-Q68c would appear 2 or 3 times, accordingly.		
Q56c	How many times did you visit the selected place**(s)** in Q55c in the past three months?	_____ times
Q57c	How much in total was spent on the treatment at the selected place(s) in Q55c? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels OR _____ USD

Q58c	How did you pay for the treatment cost at the selected place(s) in Q55c? *-Record 99 if don't know and 88 if refuse*	1= Health Equity Fund 2= Voucher 3= Fee Exemption 4= NGO 5= National Social Security Fund 6= Community-Based Health Insurance 7= Health Insurance through Employer 8= Other Privately Purchased Commercial Health Insurance 9= Wage/income 10= Loan/ Ton Tin 11= Sale of Assets 12= Gift from Relative 13= Savings 14= Other
Q59c	How much in total was spent on transport to go to and return from the selected place(s) in Q55c? *-Record 99 if don't know and 88 if refuse*	0 = free/no cost 1 = in kind 2 = _____Riels OR _____ USD
Q60c	On average how many hours do you spend to get treatment/advices from the selected place(s) in Q55c? *-Record 99 if don't know and 88 if refuse*	_____Hours
Q61c	How satisfied are you with the effect of your {treatment/care} at the selected place(s) in Q55c? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied

Q62c	How satisfied are you with the explanations the {doctor/other health professional} has given you about the results of your {treatment/care} at the selected place(s) in Q55c? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q63c	The {doctor/other health professional} at the selected place(s) in Q55c was very careful to check everything when examining you. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q64c	At the selected place(s) in Q55c, how satisfied were you with the choices you had in decisions affecting your health care? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied
Q65c	How much of the time did you feel respected by the {doctor/other health professional} at the selected place(s) in Q55c? *-Record 99 if don't know/unsure*	0 = All of the time 1 = Most of the time 2 = About half the time 3 = Some of the time 4 = None of the time
Q66c	At the selected place(s) in Q55c, the time you had with the {doctor/other health professional} was too short. *-Record 99 if don't know/unsure*	0 = Strongly agree 1 = Agree 2 = Not sure 3 = Disagree 4 = Strongly disagree
Q67c	Are you satisfied with the care you received in the selected place(s) in Q55c? *-Record 99 if don't know/unsure*	0 = Very satisfied 1 = Satisfied 2 = Neither satisfied nor dissatisfied 3 = Dissatisfied 4 = Very dissatisfied

Q68c	Would you recommend the selected place(s) in Q55c to others? *-Record 99 if don't know/unsure*	1 = Not recommended 2 = Recommend with reservations 3 = Recommend 4 = Highly recommend
Q69c	Have you ever been told by a doctor that you have eyes problems? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q70c	Have you ever been told by a doctor that you have kidney problems? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q71c	Have you ever been told by a doctor that you have lost the sensation of your peripheral membrane, such as foot, hand, arm? *-Record 99 if don't know/unsure*	0 = No 1 = Yes
Q72c	In **the past 3 months**, besides seeking medical advice or treatment for your hypertensive and diabetes condition, have you sought medical treatment or advice for other illnesses or conditions? If No, go to Section 4. If Yes, go to Q24-Q39	0 = No 1 = Yes

SECTION 4: SOCIAL SUPPORT

We would like to know if someone from your family (spouse, children, nephew, grandchildren, sibling) provide you support in general. If you need it, how often is **someone from your family** available to:

Q.N	Description and Questions	Response
Q73	have good time with	1. None of the time 2. A little of the time 3. Some of the time

		4. Most of the time 5. All of the time
Q74	turn to for suggestions about how to deal with a personal problem	1. None of the time 2. A little of the time 3. Some of the time 4. Most of the time 5. All of the time
Q75	understand your problems	1. None of the time 2. A little of the time 3. Some of the time 4. Most of the time 5. All of the time
Q76	love and make you feel wanted	1. None of the time 2. A little of the time 3. Some of the time 4. Most of the time 5. All of the time
Q77	help you if you were confined to bed	1. None of the time 2. A little of the time 3. Some of the time 4. Most of the time 5. All of the time
Q78	take you to the doctor if you needed it	1. None of the time 2. A little of the time 3. Some of the time 4. Most of the time 5. All of the time
Q79	prepare your meals if you were unable to do it yourself	1. None of the time 2. A little of the time 3. Some of the time 4. Most of the time 5. All of the time
Q80	help with daily chores if you were sick	1. None of the time 2. A little of the time 3. Some of the time 4. Most of the time 5. All of the time

SECTION 5: LIFESTYLE OR BEHAVIOUR MEASURE

Q.N	Description and Questions	Response
	Tobacco Use	
Q81	Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes? *-Record 88 if refuse to answer or 99 if don't know* **USE SHOWCARD**	0 = No 1 = Yes
Q82	Have you smoked a cigarette—even one puff—during the past SEVEN DAYS? *Record 88 if refuse to answer or 99 if don't know* **USE SHOWCARD** If No, skip Q82a.	0 = No 1 = Yes.
Q83	If yes, how many cigarettes did you smoke on average per day?	Number of cigarettes:_____
	Alcohol Use	
Q84	Have you ever consumed any alcohol such as beer, spirits or fermented palm juices? **USE SHOWCARD** *- Record 88 if refuse to answer or 99 if don't know*	0 = No 1 = Yes
Q85	During the PAST MONTH, how frequently have you had at least one standard alcoholic drink? *A drink of alcohol is defined as: one 12-oz can or bottle of beer, one 4-oz glass of wine, one 12-oz can or bottle of wine cooler, 1 mixed drink or cocktail, or 1 shot of hard liquor.* **USE SHOWCARD** *If choosing 7, skip Q86*	1 = Daily 2 = 5-6 days per week 3 = 2-4 days per week 4 = 1-2 days per week 5 = 1-3 days per month 6 = Occasionally, usually less than once a month 7 = Never

Q86	What is the largest number of drinks that you've had on any given days (a single occasion) within the last month? *(data collector need to calculate the number of drink by counting a drink of alcohol is one 12-oz can or bottle of beer, one 4-oz glass of wine, one 12-oz can or bottle of wine cooler, 1 mixed drink or cocktail, or 1 shot of hard liquor.*	_____ number of drinks
Q87	**During the past 7 days**, when you drink alcohol, how many days per week do you drink alcohol? *(Write 0 if they do not drink in the past 7 days)*	_____ number of days
Q88	On a typical day of the past 7 days, that you drink alcohol, h**ow many drinks do you have on a typical day?** *(Write 0 if they do not drink in the past 7 days)*	_____number of drinks
Diet ***A typical week*** *means a "normal" week when the diet is not affected by cultural, religious, or other events.*		
Q89	In the typical week, on how many days do you eat fruit? - *Record 88 if refuse to answer or 99 if don't know* - **USE SHOWCARD** *to show examples of fruit*	_____ days
Q90	In a typical week, on how many days do you eat vegetables? - **USE SHOWCARD** *to show examples of vegetable (Tubers such as potatoes and cassava should not be included)* - *Record 88 if refuse to answer or 99 if don't know*	_____ days

Q91	In a typical week, how many days contain fried vegetables? *- Record 88 if refuse to answer or 99 if don't know*	_____ days
Q92	In a typical week, how many days do you eat deep fried foods, snacks or fast foods? **USE SHOWCARD** *- Record 88 if refuse to answer or 99 if don't know*	_____ days
Q93	In a typical week, on how many days do you drink sugar-sweetened beverages (such as sodas, and other non-carbonated commercially prepared fruit drinks, highly sweetened tea, coffee with condensed milk)? **USE SHOWCARD** *- Record 88 if refuse to answer or 99 if don't know*	_____days
Q94	What type of oil or fat is most often used for meal preparation in your household? -Select only one appropriate response. **USE SHOWCARD** *-Record 88 if refuse to answer* *-Record 99 if don't know*	1 = Vegetable Oil 2 = Lard or Suet 3 = Butter or Ghee 4 = Margarine 5= Other (specify:) 6 = None in particular 7 = None used
Q95	How often do you add salt or a salty sauce such as soya sauce or fish sauce to your food right before you eat or as you are eating it? **USE SHOWCARD** *-Record 99 if don't know*	1 = Always 2 = Often 3 = Sometimes 4 = Rarely 5 = Always 6 = Never
Q96	How often is salt, salty seasoning or a salty sauce in cooking or preparing foods in your household? **USE SHOWCARD** *-Record 99 if don't know*	1 = Always 2 = Often 3 = Sometimes 4 = Rarely 5 = Always 6 = Never

Q97	How often do you eat processed food high in salt? By processed food high in salt, I mean food that have been altered from their natural state such as salted fish, salted meat, salted egg, instant noodles, fermented fish (prahok), ba ok, mam, kapik, packaged salty snacks, canned salty food including pickles and preserves, salty food prepared at a fast food restaurant, cheese, bacon and processed meat) **USE SHOWCARD**	1 = Always 2 = Often 3 = Sometimes 4 = Rarely 5 = Always 6 = Never
	PHYSICAL ACTIVITY	
Q98	On how many of the last SEVEN DAYS did you do **vigorous activities** for **at least 15 minutes**, such as cycling uphill or at fast pace; swimming laps; carrying heavy loads; shovelling or digging; jogging; running or a sport? **USE SHOWCARD** *Record 99 if don't know and 88 if refuse*	Number of days ⌊_⊥_⌋
Q99	On how many of the last SEVEN DAYS did you do **moderate activities** for **at least 30 minutes**, such as recreational swimming; gardening; heavy cleaning such as washing windows, vacuuming, sweeping or mopping; brisk walking; biking at moderate pace; etc.? **USE SHOWCARD** *Record 99 if don't know and 88 if refuse*	Number of days ⌊_⊥_⌋

SECTION 6: DIABETES AND HYPERTENSION KNOWLEDGE (Asking known patients only)

Q.N	Description and Questions	Response
	Diabetes Knowledge	
Q100	Eating too much sugar and other sweet foods is a cause of diabetes. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True

Q101	The usual cause of diabetes is lack of effective insulin in the body. *hint: insulin "the hormone which is responsible to regulate the glucose/sugar in the blood and control the normality of blood glucose"* *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q102	Diabetes is caused by failure of the kidneys to keep sugar out of the urine. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q103	Kidneys produce insulin. *hint: insulin "the hormone which is responsible to regulate the glucose/sugar in the blood and control the normality of blood glucose"* *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q104	In untreated diabetes, the amount of sugar in the blood usually increases. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q105	If I am diabetic, my children have a higher chance of being diabetic. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q106	Diabetes can be cured. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q107	A fasting blood sugar level of 210 is too high. Hint: Show a photo of On-Call plus *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q108	The best way to check my diabetes is by testing my urine. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q109	Regular exercise will increase the need for insulin or other diabetic medication. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True

Q110	There are two main types of diabetics: Type 1 (insulin dependent) and Type 2 (noninsulin dependent). *Hint: diabetes "type 1" occurs on any age (mostly young people) and "type 2" occur mostly on adult* *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q111	An insulin reaction is caused by too much food. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q112	Medication is more important than diet and exercise to control my diabetes. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q113	Diabetes often causes poor circulation. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q114	Cuts and abrasions on diabetes heal more slowly. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q115	Diabetes should take extra care when cutting their toenails. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q116	A person with diabetes should cleanse a cut with iodine and alcohol. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q117	The way I prepare my food is as important as the foods I eat. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q118	Diabetes can cause loss of feeling in my hands, fingers and feet. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q119	Shaking and sweating are signs of low blood sugar. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True

Q120	Frequent urination and thirst are signs of low blood sugar. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q121	Tight elastic hose or socks are not bad for diabetics. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q122	A diabetic diet consists mostly of special foods. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Hypertension Knowledge		
Q123	Increased diastolic blood pressure also indicates increased blood pressure. *Hint: Show a photo of OMRON machine* *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q124	High diastolic or systolic blood pressure indicates increased blood pressure. *Hint: Show a photo of OMRON machine* *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q125	Drugs for increased blood pressure must be taken every day. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q126	Individuals with increased blood pressure must take their medication only when they feel ill. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q127	Individuals with increased blood pressure must take their medication throughout their life. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q128	Individuals with increased blood pressure must take their medication in a manner that makes them feel good. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True

Q129	If the medication for increased blood pressure can control blood pressure, there is no need to change lifestyles. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q130	Increased blood pressure is the result of aging, so treatment is unnecessary. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q131	If individuals with increased blood pressure change their lifestyles, there is no need or treatment. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q132	Individuals with increased blood pressure can eat salty foods as long as they take their drugs regularly. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q133	Individuals with increased blood pressure can drink alcoholic beverages. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q134	Individuals with increased blood pressure must not smoke. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q135	Individuals with increased blood pressure must eat fruits and vegetables frequently. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q136	For individuals with increased blood pressure, the best cooking method is frying. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q137	For individuals with increased blood pressure, the best cooking method is boiling or grilling. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q138	The best type of meat for individuals with increased blood pressure is white meat. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True

Q139	The best type of meat for individuals with increased blood pressure is red meat. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q140	Increased blood pressure can cause premature death if left untreated. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q141	Increased blood pressure can cause heart diseases, such as heart attack, if left untreated. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q142	Increased blood pressure can cause strokes, if left untreated. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q143	Increased blood pressure can cause kidney failure, if left untreated. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True
Q144	Increased blood pressure can cause visual disturbances, if left untreated. *Record 99 if don't know and 88 if refuse*	1 = False 2 = True

SECTION 7a: MEDICATION ADHERENCE FOR HYPERTENSION (Asking known hypertension only)

Q.N	**Description and Questions**	**Response**
Can you rate the frequency with which you engaged in each of the below aspects?		
Q145 a	What type of medicine are you currently using for hypertension treatment? Hint: *this section is to assess medication adherence for those who currently administer pill (1 and 2). For patients using traditional medicine or herbal medicine (choose 3 and 4), skip this part.*	1. Pill 2. Combination between pills and traditional medicine 3. Use only traditional medicine (herbal) 4. Other (please specify)
Q146 a	Forget to take your hypertension medicines *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often

		3. Sometimes 4. Rarely 5. Never
Q147 a	Alter the dose of hypertension medicines *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never
Q148 a	Stop the hypertension medicine for a while *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never
Q149 a	Miss out on a dose of your hypertension medicine *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never
Q150 a	Take less medicines than instructed *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never

SECTION 7b: MEDICATION ADHERENCE FOR DIABETES (Asking known T2D only)

Q.N	**Description and Questions**	**Response**
	Can you rate the frequency with which you engaged in each of the below aspects?	
Q145 b	What type of medicine are you currently using for diabetes treatment? Hint*: this section is to assess medication adherence for those who currently administer pill or injection (insulin) (1, 2 and 3). For patients*	1. Pill 2. Injection (Insulin) 3. Combination between pills and traditional medicine

	using traditional medicine or herbal medicine (choose 4 and 5), skip this part.	4. Use only traditional medicine (herbal) 5. Other (please specify)
Q146 b	Forget to take your diabetes medicines *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never
Q147 b	Alter the dose of your diabetes medicines *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never
Q148 b	Stop the diabetes medicine for a while *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never
Q149 b	Miss out on a dose of the your diabetes medicine *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never
Q150 b	Take less medicines than instructed *Record 99 if don't know and 88 if refuse*	1. Very often 2. Often 3. Sometimes 4. Rarely 5. Never

Known patients with both hypertension and diabetes will have to go through Section 07a and 07b.

SECTION 8: SELF-MANAGEMENT SUPPORT (Asking known patients only)

Q.N	Description and Questions	Response
	A. Family *We would like to know how often anyone from your family offer you self-management support in the following aspects:*	
Q151	Eat healthy food with you *Record 99 if don't know and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q152	Eat unhealthy food with you *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q153	Encourage you to stick with your healthy diet *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q154	Encourage you to eat unhealthy food (such as junk food, fried food etc) *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q155	Exercise with you *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q156	Encourage you to do exercise *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q157	Help you take your medication correctly (explain based on prescription) *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week

Q158	Remind you to take your medications regularly *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q159	Encourage you to skip your medications *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q160	Help you to self-monitor of your blood pressure or blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q161	Remind you to self-monitor your blood pressure or blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q162	Remind you of your follow-up schedule at the health facility *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q163	Encourage you to visit the facility regularly for follow-up treatment *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q164	Bring you to the health facilities for follow-up visit *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
B. Non-family support *We would like to know how often anyone from non-family such as friend, neighbour, colleague or fellow patient (not peer educator) offer you self-management support in the following aspects:*		
Q165	Eat healthy food with you *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week

		4. more than once a week
Q166	Eat unhealthy food with you *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q167	Encourage you to stick with your healthy diet *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q168	Encourage you to eat unhealthy food (such as junk food, fried food etc.) *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q169	Exercise with you *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q170	Encourage you to do exercise *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q171	Help you take your medication correctly (explain based on prescription) *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q172	Remind you to take your medications regularly *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q173	Encourage you to skip your medications *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week

Q174	Help you to self-monitor of your blood pressure or blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q175	Remind you to self-monitor your blood pressure or blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q176	Remind you of your follow-up schedule at the health facility *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q177	Encourage you to visit the facility regularly for follow-up treatment *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q178	Bring you to the health facilities for follow-up visit *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
C. Community Organization *This section refers to Village Health Support Group or other people who work closely in the village to provide health-related activities **excluding** Peer Educator Network.*		
Q179	Are there anyone from community organization provide you support with your conditions? *If No, go to Part D of Peer Educator*	0 = No 1= Yes
If you need it, how often is someone from community organization or community health worker available to:		
Q180	Give you suggestions about how to deal with health problem *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q181	Provide you guidance on available health service at the public health facilities	1. Never 2. less than once a week

	Record 99 if don't know/not applicable and 88 if refuse	3. once a week 4. more than once a week
Q182	Bring you to the health facilities if you need help *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q183	Introduce you the healthy diet *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q184	Encourage you to eat healthy food *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q185	Encourage you to eat unhealthy food *Give example of unhealthy food* *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q186	Introduce you how to be physically active *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q187	Encourage you to do exercise *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q188	Help you to take your medication correctly (explain based on prescription) *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q189	Remind you to take your medications regularly *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week

		4. more than once a week
Q190	Encourage you to skip your medications *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q191	Help you to self-monitor of your blood pressure or blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q192	Encourage you to self-monitor your blood pressure of blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q193	Remind you of your appointment schedule at the health facility *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q194	Encourage you to visit health facility regularly for follow-up appointment *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q195	Visit your home for individual health education *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q196	Provide group health education on self-management *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q197	Are you satisfied with the support you received from community health workers? *Record 99 if don't know/not applicable and 88 if refuse*	1. Very satisfied 2. Satisfied 3. neutral 4. Dissatisfied 5. Satisfied

D. Peer Educator Network *(Diabetic patients working for MoPoTsyo)*		
Q198	Is there anyone from **peer educator network** providing you support in general and with your health conditions? *If No, go to Section 9.*	0 = No 1= Yes
*If you need support, how often is **someone from peer education network** available to:*		
Q199	Give you suggestions about how to deal with health problem *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q200	Provide you guidance on available health service at the public health facilities *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q201	Bring you to the health facilities if you need help *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q202	Introduce you the healthy diet *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q203	Encourage you to eat healthy *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q204	Encourage you to eat unhealthy food *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q205	Introduce you how to be physically active *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week

		4. more than once a week
Q206	Encourage you to do exercise *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q207	Help you to take your medication correctly (explain based on prescription) *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q208	Remind you to take your medications regularly *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q209	Encourage you to skip your medications *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q210	Help you to self-monitor of your blood pressure or blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q211	Encourage you to self-monitor your blood pressure or blood glucose *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q212	Remind you of your appointment at the health facility *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q213	Encourage you to visit health facility regularly for follow-up appointment *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week

Q214	Visit your home for individual health education *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q215	Provide group health education on self-management *Record 99 if don't know/not applicable and 88 if refuse*	1. Never 2. less than once a week 3. once a week 4. more than once a week
Q216	Are you satisfied with the support you received from the peer educator network? *Record 99 if don't know/not applicable and 88 if refuse*	1. Very satisfied 2. Satisfied 3. neutral 4. Dissatisfied 5. Very dissatisfied

SECTION 9: DECISION MAKING POWER ON DIET (Asking known patients only)

We want to understand to what extend you have power in food making/consumption in your family.		
Q217	Who is your household's primary grocery shopper?	1. yourself 2. spouse 3. other in the household
Q218	Whose preference did the shopper accommodating to most of the time?	1. yourself 2. spouse 3. other in the household
Q219	Who is in your household usually prepares food?	1. yourself 2. spouse 3. other in the household
Q220	Whose preference did the cook accommodating to most of the time?	1. yourself 2. spouse 3. other in the household
Q221	How much influence do you have in the decision on what you eat?	1. Somebody else decides for me, I never make the decision 2. Somebody else decides for me, I rarely make the decision 3. Somebody else decides and I sometimes make the decision

		4. I often make my own decision 5. I always make my own decision without any interference

SECTION 10: ANTHROPOMETRIC MEASUREMENTS

Q.N	Description and Questions	Response
Q222	Height	_____Cm
Q223	Weight	_____Kg
Q224	Waist circumference	_____ Cm
Q225	Hip circumference	_____ Cm
Q226	Blood pressure, reading 1	_____Systolic (mmHg) _____Diastolic (mmHg)
Q227	Blood pressure, reading 2	_____Systolic (mmHg) _____Diastolic (mmHg)
Q228	Blood pressure, reading 3	_____Systolic (mmHg) _____Diastolic (mmHg)

SECTION 11: BIOMARKER MEASUREMENTS

Q.N	Description and Questions	Response
Q229	During the past 10 hours have you had anything to eat or drink other than plain water? *-If YES, do not proceed.*	0 = No 1 = Yes
Q230	Fasting Blood Glucose	_____mg/dl
Q231	HbA1c	_____ mmol/m
Q232	Creatinine	_____ mg/dl

[End of Questionnaire]

Annex 4. Integrated Care Package (ICP) Implementation Assessment Framework _ ICP Grid

General explanation of the ICP grid:
Most of the questions in this assessment framework are adapted from the Innovative Care for Chronic Conditions (ICCC) Framework situation assessment. We aim to rate the integrated care package at a particular Unit of Analysis (an Operational District including a referral hospital and a number of health centers). The grid includes questions on the five components of the ICP and additional questions on overarching axis that relate to quality control (component 6). The ICP components measure both structure (are the necessary structures present?) and process (are processes done consistently and with which level of depth?).

Methods for filling the grid:
The ICP grid is not a direct data collection tool. It is rather a meta-analysis or synthesis of multiple data sources. The grid should be filled during analyses of data collected from the multiple sources (for the triangulation purpose). Two raters are required to fill the grid independently. A consensus between the raters should be reached after checking the collected data. Data are collected through:

- Key information interviews with representatives (director or deputy director) from the respective provincial health department, operational district, and referral hospital
- Focus group discussions with health care staff from health centers and the NCD clinic of the referral hospital
- Focus group discussions with community health workers including village health support group and peer educator network
- Focus group discussions or in-depth interviews with people living T2D
- Direct observations of the health facility infrastructure, organization of work, patient flow, interactions of patients with health care workers
- Inspection of records or documents at the health facilities: management books, patient registries, and randomly selected patient files

Grading and scoring:
Response to each question is graded using a scale of 0 to 5 with an explanation of each grade.

- ➢ 0 : No implementation of ICP
- ➢ 1 : Little implementation of ICP
- ➢ 2-3 : Moderate implementation of ICP
- ➢ 4 : Almost complete implementation of ICP
- ➢ 5 : Full implementation of ICP

Note on terminology:
- BMI : Body mass index
- BP : Blood pressure
- HCW : Health care workers including both physicians and non-physicians
- Physicians : medical doctors

- Non-physicians : nurses or community health workers or other HCWs
- NCD : Non-communicable disease
- T2D : Type 2 Diabetes

Additional text to instruction for researchers filling the grid, especially on how to grade COMPETENCE:
They need to be well aware of the national guidelines (or golden standard where it is available) on how to diagnose, how to treat, how to provide information and self-management support. They will need to rate the competence of health care providers by observing providers and sometimes talking with providers, to see whether they act in according with the guidelines. This is an important aspect of field training.

Operational District: _____ Province: _____

Assessment Date: _____

Analyzed and scored by: _____

ICP Component	**Response**						**Verified by**	**Justification**
Component 1: Facility based identification of patients with T2D *Facility: place (health center, hospital, clinic, home, headquarter) where care is provided*	**No or little implementation**		**Moderate implementation**		**Almost complete or full implementation**			
1.1. To what extent, is screening for T2D performed among patients at a visit? [PROCESS]	**0** Not at all	**1** Only on patient's initiative, not based upon HCW thinking of it (client-based)	**2** When diabetes symptoms are present or required by other conditions	**3** When required by risk factors but not consistently done	**4** Consistently done in a group of patients defined by risk factors (almost everyone).	**5** Everyone who needs to be tested gets tested.	-Asking health care staff (supported by observation and checking records at the triage)	
1.2. To what extent, are **equipment and materials** necessary for diagnosing patients	0 Not at all	1	2 Partially equipped –	3 Equipped for a small	4 Fully equipped for	5 Fully equipped for everyone	-Asking health care staff (supported by	

for **T2D** available at the facility? [STRUCTURE]		Available but not functional	some parts are not functional	number of patients	almost everyone		observation at the facility)	
1.3. To what extent, are health care staff or service providers **competent** to perform **diagnosis for T2D** at the facility? [STRUCTURE/EDUCATION]	0 Not at all	1 Know but cannot perform properly	2 Perform with guidance from others	3 Properly perform but cannot interpret the results	4 Properly perform with limited interpretation of the results	5 Properly perform with clear interpretation of the results	-Asking health care staff if they are educated about diagnosis criteria for T2D	
1.4. To what extent is the **follow-up of the patients after the screening, testing and diagnosis of T2D** organised? [PROCESS]	0 No follow up	1 Patients are referred for diagnosis/ therapy but no follow up	2 Follow up only on patient's initiative	3 Follow up on if positive diagnosed and not follow up if negative with high risk	4 Follow up for both positive and negative with high risk	5 Care is organised and planned for every patient and they are called if non-attending	-Asking the health care staff	
Component 2: Treatment of T2D by primary care providers using standardized protocols *Primary care providers: first line of care providers (not including those at hospitals)*	**No or little implementation**		**Moderate implementation**		**Almost complete or full implementation**			
2.1. To what extent, are **written guidelines of care and treatment** accessible to primary care providers for T2D? [STRUCTURE]	0 Not available at all	1 Some guidelines are available but not used in daily practice or difficult to access	2 Easy accessible guidelines but not recently updated and not encouraged	3 Easy accessible guidelines and recently updated or their use is encouraged	4 Recent updated guidelines are available and their use is encouraged through posters and other	5 Recent updated guidelines are available and integrated in daily practice through reminders (pop-ups) in electronic medical record	-Asking the providers to show guidelines: how easy/difficult the health care staff can show the guidelines when asked to present them. -Observation at the facility	

					educational process etc.	tailored to each patient		
2.2. To what extent, are primary care providers in charge **competent to provide treatmen**t for patients with T2D? [STRUCTURE/EDUCATION]	0 No knowledge at all	1 Have some non-pharmacological knowledge	2 Have non-pharmacological knowledge and skills	3 Have detailed knowledge and non-pharmacological skills plus basic pharmacological knowledge	4 Have all detailed knowledge about pharmacological treatment	5 Have detailed knowledge and know how to treat complications	-Asking the health care staff	
2.3. To what extent are the **essential medications** for T2D available in the primary care setting? [STRUCTURE]	0 Not at all	1 Only some medications available but stock out	2 Accessible to one type of medicines	3 Accessible to two or more of medicines	4 Accessible to two or more of medicines and indicated	5 Fully accessible to all the essential medicines (including insulin) and indicated	-Asking the health care staff -Checking the drug store against anti-diabetic medicines listed in the national guidelines)	
2.4. To what extent, do primary care providers have necessary **laboratory access**? [STRUCTURE]	0 Not at all	1 All testing items referred to the referral hospital	2 Limited testing items by rapid tests	3 All testing items by rapid tests	4 Limited testing items by own laboratory	5 All testing items by own laboratory	-Asking the health care staff -Checking the laboratory capacity at the facility	
2.5. To what extent have primary care providers received **training for treating** T2D? [STRUCTURE/EDUCATION]	0 Not at all	1 On the job training or when the service started	2 Part of the formal education to obtain certificate	3 as in 2 plus sporadic extra trainings on the topic	4 As in 2 plus systematically extra trainings on the topic	5 As in 2 plus systematically extra obligatory trainings on the topic, with	-Asking the health care staff -Checking details of trainings (when?	

			needed to do the job			innovative methods	trained by whom? how long? about what?)	
2.6. How comprehensive is **treatment beyond medication prescription for T2D** (including measuring of BMI, waist circumference, BP measurements, cholesterol levels, renal function, screening for complications – foot exam, eye problems, macrovascular disease, depression)? [PROCESS]	0 Not at all	1 Some elements	2 Most elements	3 All elements but not consistently	4 All elements and most of the time	5 All elements and systematically	-Asking the health care staff	
2.7. To what extent are **medication reviews undertaken in elderly** with T2D in order to avoid polypharmacy, hypoglycemia and renal dysfunction? [PROCESS]	0 No medication reviews	1 For some patients based on HCW's own initiative	2 Routinely done	3 Routinely done and sometimes seeking advice from pharmacist	4 This is sometimes done in a multidisciplinary setting (including pharmacist)	5 This is routinely done in a multidisciplinary setting (including pharmacist)	-Asking the health care staff	
Component 3: **Health education and counselling to patients with T2D by non-physician care providers**	**No or little implementation**		**Moderate implementation**		**Almost complete or full implementation**			
3.1. To what extent, do patients with T2D receive **information on how to reduce health risks** by non-physicians? *(information on chronic disease management and lifestyle support)* [PROCESS]	0 Not at all	1 Only informal education is given	2 Within consultation by a non-physician	3 Structured individual education by a non-physician is scheduled	4 A multidisciplinary team provides structured education to	5 Group sessions by a multidisciplinary team, the sessions are quality assured	-Asking nurses or community health workers or other HCWs -Checking with patients -Observation (if possible)	

				for every patient	groups of patients	(reviewed) and made use of interactive techniques such as videos, discussion, etc.		
3.2. To what extent, are patients **informed about the chronic condition** of T2D by non-physicians (including the expected course, expected complications, and effective strategies to prevent complications and manage symptoms)? *(information on the prognosis)* [PROCESS]	0 Not at all	1 Only informal education is given	2 Within consultation by a non-physician	3 Structured individual education by a non-physician is scheduled for every patient	4 A multidisciplinary team provides structured education to groups of patients	5 Group sessions by a multidisciplinary team, the sessions are quality assured (reviewed) and made use of interactive techniques such as videos, discussion, etc.	-Asking nurses or community health workers or other HCWs -Checking with patients -Observation (if possible)	
3.3. To what extent, are non-physicians **trained to provide health education and counselling** to patients with T2D? [STRUCTURE/EDUCATION]	0 Not at all	1 On the job training (formal education at college or university)	2 On the job training (formal education at college or university) and when the service started	3 as in 2 plus sporadic extra trainings on the topic	4 As in 2 plus systematically extra trainings on the topic	5 As in 2 plus systematically extra obligatory trainings on the topic, with innovative methods	-Asking nurses or community health workers or other HCWs	
3.4. To what extent, are **health education or counselling materials** accessible to non-physicians for	0	1	2	3 Partially accessible to	4 Fully accessible to	5		

T2D? [STRUCTURE]	Not available at all	Available (some materials)	All available but not accessible	all necessary materials	almost all necessary materials	Fully accessible to all necessary materials	-Asking nurses or community health workers or other HCWs to show it -Observation at the facility	
Component 4: Self-management support to patients and their informed caregivers with tools for adherence and monitoring *Self-management support: supporting patients to self-manage their conditions (practice and reinforce)*	**No or little implementation**		**Moderate implementation**		**Almost complete or full implementation**			
4.1. To what extent, are patients offered **self-management training** for T2D (for example, to improve adherence to medications, proper nutrition, having self-monitoring tools at home, consistent exercise, tobacco cessation, and maintain other healthy behaviours)? [PROCESS]	0 Not at all	1 Little offer (only one element of the list) and not systematically offered to every patient	2 Limited offer (more than two elements in the list) but not systematically offered to every patient	3 Limited offer (more than two elements in the list) and systematically offered to every patient	4 Offer all the elements in the list but not systematically offered to every patient	5 Offer all the elements in the list and systematically offered to every patient	-Asking nurses or community health workers or other HCWs	
4.2. To what extent, do health care staff or community health workers **support patients' self-management** efforts **on a continuous basis for T2D?**	0 Not at all	1 Only once when the care started	2 In most visits, but no use of telephone/apps	3 Once a year via telephone or email	4 Once per quarter via telephone call or email	5 On every visit and supported with commonly used apps	-Asking nurses or community health workers or other HCWs	

[PROCESS]								
4.3. To what extent, are health care staff or community health workers **competent to perform self-management training?** [STRUCTURE/EDUCATION]	0 Not at all	1 Know but cannot perform (no confidence or lack of equipment or materials	2 Can perform with guidance from others	3 Can perform limited training lessons	4 Can perform almost all the training lessons	5 Can perform all the training lessons	-Asking nurses or community health workers or other HCWs	
4.4. To what extent, does the patient have **access to materials for self-monitoring for T2D**, for instance, glucose meter/ glucose test strips? [STRUCTURE]	0 Not at all	1 Exist in theory but access for patients is not organized	2 Access for some patients to all materials needed but refills lack	3 Access for some patients to all materials needed including refills (strips, lancets)	4 Well-organized with access for all patients to all materials needed but refills lack	5 Well-organized with access for all patients to all materials needed including refills (strips, lancets)	-Asking nurses or community health workers or other HCWs	
4.5. To what extent are **informal caregivers/non-medical** involved in the self-management process for T2D? *(i.e. family, social worker, community workers, organizations - it must be informal and not part of the health care system)* [PROCESS]	**0** Not at all	**1** Occasionally involved but no health knowledge	**2** Occasionally involved with limited health knowledge	**3** Fully involved with limited health knowledge	**4** Fully involved with full knowledge but not receiving any supporting materials	**5** Fully involved with full knowledge and receiving supporting materials	-Asking nurses or community health workers or other HCWs	
4.6. Are the **concerns of patients and families** addressed? [PROCESS]	0 Not at all	1 Is not	2 Is provided for specific	3 Is provided for specific	4 Is encouraged,	5 Is an integral part of primary		

		consistently done	patients and families through referral	patients and families in the health facility	and peer support, groups and mentoring program is available	care and includes systematic assessment and routine involvement in peer support, group or mentoring program	-Asking nurses or community health workers or other HCWs	
4.7. Are **patient treatment plans** agreed with patients, reviewed and written down? [PROCESS]	0 Patient treatment plans not expected	1 Patient treatment plans only sometimes written down	2 Patient treatment plans achieved through a standardized approach for the majority of patients	3 Patient treatment plans with clinical goals established collaboratively with patients	4 Patient treatment plans with clinical goals and self-management established collaboratively with patients	5 Patient treatment plans with clinical goals, self-management, and follow-up care established collaboratively with patients	-Asking nurses or community health workers or other HCWs	.
Component 5: **Structured collaboration between health care workers, community actors, and patients and caregivers**	**No or little implementation**		**Moderate implementation**		**Almost complete or full implementation**			
5.1. To what extent, is there an identified **"care coordinator"** who serves as the overseer and director of a patient's care, ensuring that efforts of all involved health care workers, community actors, and patients and caregivers are	0 Not exist	1 Exist but not active	2 Exist and active only when triggered	3 Exist and active occasionally	4 Exist and active but not structured	5 Exist and active and structured	-Asking the health care staff -Checking in the community	

integrated and coordinated for T2D? [STRUCTURE]								
5.2. To what extent, do the **health care organization and the community** have **complementary functions**, that is, community organizations fill gaps in services that are not provided in formal health care for T2D? [PROCESS]	0 Not at all	1 Community effort exists but not relevant to the gap	2 Community effort exists and relevant but unable to fill the gap	3 Community effort exists and able to limitedly fill the gap	4 Community effort exists and able to almost fill the gap	5 Community effort exists and able to completely fill the gap	-Asking the health care staff and patients -Checking in the community	
5.3. To what extent, are **referral practices** systematically organized for T2D? [PROCESS]	0 Not at all	1 Oral referral only	2 Written referral and only one direction	3 Written referral for two directions (without tele-communication)	4 Written referral organized for two directions (confirmed by tele-communication) and case by case	5 Written referral organized systematically for two directions for all cases (confirmed by tele-communication)	-Asking the health care staff	
5.4. To what extent does **cooperation between health care workers and other professionals and community actors** occur for T2D? [PROCESS]	0 No cooperation	1 Little cooperation without regular discussion	2 Moderate cooperation within the team with regular discussion	3 Full cooperation within the team but not across	4 Cooperation within and across the team	5 Multi-disciplinary cooperation within the team and across all levels	-Asking the health care staff	

5.5. To what extent is the traditional **hierarchy flattened** and moved away from physician dominated models for T2D? [STRUCTURE]	0 Specialists are dominating and in the first line	1 Specialists are central for some patients, and for some general practitioners play the central role	2 General practitioners are central, and other HCWs play a minor role	3 General practitioners are central, and other HCWs play a big role	4 There is a multidisciplinary team and everyone is considered equal	5 HCWs with special training in chronic care take the lead	-Asking the health care staff	
Component 6: Organization of care, delivery system design and clinical information systems	**No or little implementation**		**Moderate implementation**		**Almost complete or full implementation**			
6.1. To what extent are ongoing **quality improvement** routine activities among health care workers organized? [PROCESS]	0 No quality improvement	1 New rules to improve care quality are sometimes set from managemen t	2 When a problem pops up a quality improvement activity is sometimes undertaken	3 When a problem pops up a quality improvement activity is often undertaken	4 Is a routine process but results from previous rounds are often not taken into account	5 Is a routine process and results from previous rounds are taken into account	-Asking the health care staff and management team of RH, OD or PHD	
6.2. To what extent do **information systems** gather and organise data about epidemiology, treatment, and health care outcomes? [STRUCTURE]	0 There is no registry	1 There is a registry but is not used for treatment purpose	2 The registry includes name, diagnosis, contact information and date of last contact	3 The registry includes name, diagnosis, contact information, date of last contact,	4 The registry includes all the information in 3 and also allows queries to sort	5 As in 4, the registry is also tied to guidelines which provide prompts and reminders about services needed	-Asking the health care staff and management team of RH, OD or PHD	

				treatment and outcomes	subpopulations by clinical priorities			
6.3. To what extent do information systems serve a **reminder function** for patient specific prevention and follow-up services (e.g. to identify patients' needs, to follow-up and plan care, to monitor responses to treatment, and to assess health outcomes)? [STRUCTURE]	0 No Information system	1 There is a system but no reminder function	2 There is a system and reminders that include general notification of the existence of a chronic illness, but does not describe services needed at time of encounter	3 There is a system and reminders that describe services needed at time of encounter, based on general guideline, not patient-specific	4 There is a system that includes specific information for each patient at the time of individual patient encounter	5 As in 4, the system also includes specific information for the health care team about adherence to patient care plan at the time of individual patient encounter	-Asking the health care staff and management team of RH, OD or PHD	
6.4. To what extent is **feedback about the performance provided to the team and its members**? [PROCESS]	0 Not available	1 Non-specific to the team	2 Infrequent intervals and not delivered to the team (they need to search for the information)	3 Frequent intervals but not specific for the team and impersonally delivered (just common reports)	4 Occurs at frequent enough intervals to monitor performance and is specific to the team	5 Timely and specific to the team, routinely and personally delivered by a respected opinion leader	-Asking the health care staff and management team of RH, OD or PHD	
6.5. To what extent is an **appointment system** with planned visits used? [STRUCTURE]	0	1 Used to	2 Appointmen t system	3 Appointmen t system	4 Appointmen t system is	5 Appointment system includes	-Asking the health care staff	

	No appointment system	schedule acute care visits, follow-up and preventive visits	assures scheduled follow-up with chronically ill patients, but some patients escape the system	assures scheduled follow-up with all chronically ill patients	flexible and can accommodate innovations such as customized visit length or group visits	organisation of care that facilitates the patient seeing multiple providers in a single visit		

--The End--