

Healthcare utilization 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 utilization 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 in Cambodia.

Participants: Data was from 2,360 participants aged ≥ 40 years who had used healthcare services at least once in the three 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 three 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). In people with T2D and/or HTN, increased public healthcare use was significantly associated with Health Equity Fund (HEF) membership and living in operational districts with *community-based care*. Furthermore, significant healthcare expenditure reduction was associated with HEF membership and using public healthcare facilities in these populations.

Conclusion: Overall public healthcare utilization was relatively low; however, it was higher in people with chronic conditions. HEF membership and *community-based care* contributed to higher public healthcare utilization 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 increase public healthcare utilization among people with T2D and/or HTN, the public healthcare system should further

46 improve care quality, expand social health protection, and expand *community-based care* for this
47 population. However, these may require more time and resources. One potential strategy in the
48 short run is to partner the private sector with the public sector.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Our study is among the few to examine healthcare utilization and expenditure among people with two major chronic conditions type 2 diabetes (T2D) and/or hypertension (HTN) in Cambodia, in comparison with the people without the two conditions.
- The findings in this study provides could inform decision-makers about strategies for T2D and HTN management in Cambodia and similar settings.
- Our study is not representative for the national level as most of the study sites we selected were rural or semi-rural.
- We only calculated the healthcare expenditure for those who used the service in the three months preceding the study, which cannot be generalized to the target population in the study (people aged 40 years or older).

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- 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 utilization and expenditure.^{6 7} 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.⁸ This study shows that 61% of the people with T2D and/or HTN who knew their status were diagnosed in private facilities.⁸ However, this study collected data in 2013, before key interventions were introduced or expanded in public healthcare facilities.⁹ 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 to 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.⁹ These models include *hospital-based care*, *health center-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 utilization and related expenditure, especially among people with T2D and/or HTN.

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 Non-communicable Disease (NCD) clinic at the district referral hospitals.⁹ By 2021, 31 out of 117 referral hospitals had implemented this model.
- The *health center-based care* model adopts the World Health Organization Package of Essential Non-communicable Disease Interventions (WHO PEN).⁹ In this model, the MoH added the function of a health center to *hospital-based care*. However, the coverage of health centers with the WHO PEN varies in each OD, which can be divided into low coverage (<50% of all health centers implement the WHO PEN; *health center-based care (low)*) and high coverage ($\geq$ 50% of all health centers implement the WHO PEN; *health center-based care (high)*). The referral flow is slightly different between T2D and HTN. For T2D, this model identifies cases in the health centers through a screening test. If the patients are suspected of having T2D, health centers 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 centers. For HTN, the health centers treat mild patients and refer the severe cases to the referral

hospital. By 2021, *health center-based care* was implemented in 137 of 1,221 health centers.

- The *community-based care* model or peer education network established and run by MoPoTsyo, a local non-governmental organization.⁹ 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 counseling 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.^{9 10} It had 225 PEs to serve 40,000 people with T2D.¹⁰
- 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.

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91 A better understanding of the current patterns of healthcare utilization and expenditure among

92 people with T2D and/or HTN is critical for better targeting resources and strategies to improve

93 the management of T2D and HTN. The main objectives of this study are two-fold. First, it

94 evaluates usage and determines the factors associated with public healthcare use in four groups:

95 (1) people without T2D or HTN, (2) people with T2D alone, (3) people with HTN alone, and (4)

96 people with T2D plus HTN. Second, it assesses the healthcare expenditure in the three months

97 preceding the survey for all services used by the four patient groups in public and private

98 facilities and determines factors associated with (reducing or increasing) healthcare expenditure.

METHODS AND CONTEXT

Context

The health system in Cambodia is pluralistic, meaning healthcare services are provided by both public and private healthcare providers.^{5 11}

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 centers, district referral hospitals, provincial referral hospitals, and national hospitals.⁵ Public healthcare is organized 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 center 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 center, but it is smaller than a health center.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 centers.

Alongside this public sector, a large *private healthcare sector*, which is more accessible than the public sector, dominates outpatient curative care.⁵ Since 1994, the Cambodian government started economic liberalization, permitting staff to work outside their government’s working hours and own healthcare facilities.⁵ Since then, the private healthcare sector and dual practice, 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

123 medical consultation services.^{12 13} According to the MoH Progress Report in 2018, over 90% of
 124 private healthcare facilities were cabinets.^{12 13} The second most frequent facilities were clinics
 125 (3.2%), providing medical specialties, laboratories, radiology services, and pharmacies.¹² A
 126 clinic has between 10 and 20 beds.¹² In addition, buying medication in pharmacies or drugstores
 127 for self-treatment without a doctor's prescription is common in Cambodia, although not
 128 permitted by law.¹⁴

129 In terms of health expenditure, the public healthcare sector did not charge user fees until 1996.⁵
 130 In that year, the government also introduced a user-fee scheme for the public sector with fees
 131 approved by the local community to increase healthcare quality at public healthcare facilities.^{5 15}
 132 The revenue from the user-fee scheme could be used to incentivize staff and support ongoing
 133 operations. However, the user-fee posed challenges for the poor to access public healthcare. To
 134 address this, the MoH established the Health Equity Fund (HEF) in 2000, a pro-poor social
 135 health protection scheme.¹⁶ The HEF is linked to the implementation of identification of the poor
 136 (known as "IDPoor").¹⁷ It is intended for the "extremely poor" or "poor" category, which is
 137 assessed and verified by the local authorities.¹⁷ People with IDPoor are entitled to the HEF,
 138 meaning that they receive free healthcare services at public healthcare facilities and
 139 transportation expenditure reimbursement.¹⁷ By 2019, the HEF covered approximately three
 140 million or about 20% of Cambodia's population.¹⁶ Another scheme was the National Social
 141 Security Fund (NSSF), established in 2007.¹⁸ The NSSF covers work and non-work-related
 142 illnesses and injuries for formally employed people.¹⁸ Formal employers are mandated to pay for
 143 their staff's NSSF membership. The NSSF had enrolled over 1.7 million employees or about
 144 11% of the population by 2019.¹⁹

However, it is important to note that several studies have indicated that the private sector constitutes a significant source for out-of-pocket expenditure (OOPE).^{20 21} 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 USD 40.6 in 2009 to USD 48.1 in 2016.²¹ In 2016, 76.6% of the total OOPE was linked to private healthcare.^{20 21}

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-center based care (high)*, *health-center 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 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 NCD clinic was established in 2002, and the peer educator network was initiated in 2007 and handed over to the MoH in

2015.²² The WHO PEN was implemented in 5 out of 14 health centers 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 kilometers 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 center-based (high)” model, and was the OD with high coverage of the WHO PEN. Six out of nine health centers 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 center-based (low)” model, and was the OD with low coverage of the WHO PEN (6/25 of the health centers 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.²³
- *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 is a remote area bordering Thailand, approximately 470 kilometers 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 5,072 individuals aged 40 years or older to participate in the study using a multi-stage 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 minimize 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 three months preceding the survey (Figure 1). A total of 2,360/5,072 participants met this criterion. The 2,360-participant sample subset included four patient groups: 1,331 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

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 ⁷ Since our study only focuses on healthcare utilization and expenditure, we only used information from step 1—interviews with a structured questionnaire. The questionnaire was tablet-based and comprised of 11 sections, including socio-demographic information, health status and quality of life, healthcare utilization, social support, lifestyle or behavior 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: socio-demographic information and healthcare utilization.

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.²⁴

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 centers, and health posts. A health post is similar to a health center, and only a few exist in remote areas. Therefore, we grouped them with health centers. Private healthcare services are non-government organizations 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 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). We include the questionnaire in Annexure 2. The Cambodian currency (riels) was converted into USD at an exchange rate of 4,000 riels per USD. The expenditure does not include other spendings 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 center-based (high)*, *health center-based (low)*, and *community-based*). The details on wealth quintile calculation (socio-economic class) are described in Annexure 3.

Analysis

Healthcare utilization

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

To identify the independent factors associated with healthcare utilization (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.

Medical expenditure

We took healthcare expenditure in the three 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 90th 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 medical 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 ANOVA 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% confidence interval (CI) values were exponentiated to a risk ratio (RR) for better interpretation.

Data were analyzed using Stata 16.0 (Stata Corp LLC, College Station, Texas 77, USA), and R programming's GGLOT2 package was used to produce the graphs.

Ethical approval

The protocol was approved by the National Ethics Committee for Human Research (NECHR) on April 29, 2019 (No. 105 NECHR) and by the Institutional Review Board of Institute of Tropical Medicine (Antwerp) on October 25, 2019 (No. 1,323/19). All participants provided their consent and volunteered to take part in the study.

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.

RESULTS

Characteristics of participants

Our analysis included 2,360 participants, including 1,331 people without T2D or HTN, 761 people with HTN alone, 109 with T2D alone, and 159 with T2D plus HTN. The other participants were excluded because they had not used healthcare services in the three months preceding the survey (N=2,703) or had a missing response to the primary variable of interest (N=9).

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).

Table 1. Demographic and socio-economic characteristics of participant, 2020, Cambodia

Variable	Overall (N=2360)	No T2D/HTN (N=1331)	HTN (N=761)	T2D (N=109)	T2D plus HTN (N=159)	P- value
		n (%)	n (%)	n (%)	n (%)	
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 center-based (high)	486 (20.6)	257 (19.3)	174 (22.9)	27 (24.8)	28 (17.6)	
Health center-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)	

321 **Public and private healthcare utilization**

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

Public healthcare utilization 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 utilization at a P -value<0.25 in at least one patient group. Therefore, we included these variables in the multiple negative binomial regressions.

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

Variable	Overall (N=6645)		No T2D/HTN (N=3467)	HTN (N=2345)	T2D (N=320)	T2D plus HTN (N=513)
	User (%)	rate	User rate (%)	User rate (%)	User rate (%)	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 socio-economic 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 center-based (high)	14.7	13.2	14.8	19.0	23.8
Health center-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

Abbreviation: NSSF, National Social Security Fund; HEF, Health Equity Fund

Note:

- The % of private healthcare is not presented in this table but can it be calculated by subtracting the % of the public healthcare from 100%.
- Health center-based (high) means the OD with high coverage (six out of nine) of health centers with the WHO PEN; Health center-based (low) means the OD with low coverage (six out of 25) of health centers 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.

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 1.0–2.0], *P*-value<0.05). We did not observe the same association in the other three groups.

369 In people with HTN, the poorest category was significantly associated with increasing public
370 healthcare use with an AIRR of 2.1 [95% CI 1.1–4.0], P -value=0.02), compared to those in the
371 richest category. Nevertheless, the same association was not seen in other patient groups.
372 Regarding the care model, in people with T2D, the OD with *community-based care* (AIRR 3.7
373 [95% CI 1.2–11.3], P -value=0.019) and the OD with low coverage of *health center-based care*
374 (AIRR 3.3 [95% CI 1.1–9.8], P -value=0.036) were significantly higher in public healthcare use
375 than in the OD with *hospital-based care*.
376 In people with T2D plus HTN, the OD with *coexisting care* was associated with higher public
377 healthcare use (AIRR 4.0 [95% CI 1.2–12.9], P -value=0.020).

378
379 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 [0.8–1.2]	—	—	—	—
T2D	1.9 [1.3–2.9]**	—	—	—	—
T2D plus HTN	1.9 [1.3–2.7]***	—	—	—	—
Age in year					
40–49	Ref.	Ref.	Ref.	Ref.	
50–59	1.2 [0.9–1.5]	1.4 [1.0–1.9]	0.6 [0.3–1.2]	1.5 [0.5–4.5]	1.2 [0.3–4.2]
60+	1.1 [0.8–1.4]	1.2 [0.9–1.7]	0.7 [0.4–1.3]	1.5 [0.5–4.5]	0.6 [0.2–2.2]
Having NSSF membership					
No	Ref.	Ref.	Ref.	Ref.	
Yes	1.4 [0.9–2.1]	1.0 [0.5–1.8]	2.0 [0.9–4.6]	2.3 [0.5–10.1]	1.9 [0.7–4.8]
Having HEF membership					
No		Ref.	Ref.	Ref.	
Yes	1.4 [1.1–1.8]*	1.4 [1.0–2.0]*	1.4 [0.9–2.3]	2.1 [0.8–5.1]	1.9 [1.0–3.7]
Household socio-economic class					
Poorest	1.4 [1.0–2.0]*	1.0 [0.7–1.6]	2.1 [1.1–4.0]*	1.2 [0.4–3.5]	2.6 [0.9–7.1]
Poor	1.2 [0.9–1.7]	1.1 [0.7–1.7]	1.2 [0.7–2.3]	0.7 [0.2–2.1]	2.6 [1.0–7.3]
Medium	1.1 [0.8–1.5]	0.9 [0.6–1.4]	1.2 [0.7–2.3]	0.9 [0.4–2.2]	3.0 [1.2–7.7]
Rich	1.1 [0.8–1.4]	1.1 [0.7–1.7]	1.0 [0.6–1.8]	1.2 [0.4–3.5]	1.7 [0.7–4.1]
Richest	Ref.	Ref.	Ref.	Ref.	Ref.
Care model					
Coexisting	1.4 [1.0–1.9]*	1.5 [1.0–2.3]	1.3 [0.7–2.3]	2.5 [0.8–7.6]	4.0 [1.2–12.9]*
Community-based	0.9 [0.7–1.2]	1.0 [0.6–1.5]	0.5 [0.3–1.0]	3.7 [1.2–11.3]*	1.7 [0.5–6.1]

Health center-based (high)	0.8 [0.6–1.1]	0.8 [0.5–1.3]	0.7 [0.4–1.3]	1.3 [0.4–3.9]	2.7 [0.9–8.8]
Health center-based (low)	1.0 [0.8–1.4]	1.4 [1.0–2.1]	0.6 [0.3–1.0]	3.3 [1.1–9.8]*	3.0 [1.0–9.1]
Hospital-based	Ref.	Ref.	Ref.	Ref.	Ref.

(*) P -value<0.05, (**) P -value<0.01, (***) P -value<0.001

Abbreviation: AIRR, adjusted incidence rate ratio; CI, confidence interval; Ref., reference group; OD, operational district

Note: Health center-based (high) means the OD with high coverage (six out of nine) of health centers with the WHO PEN; Health center-based (low) means the OD with low coverage (six out of 25) of health centers with the WHO PEN

Healthcare expenditure

Medical cost per year, overall and by facility

Overall, those who used healthcare spent an average of USD 25.3 [95% CI 22.9–27.6] for all healthcare services in the three months preceding the survey (Figure 3).

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

Figure 3. Healthcare expenditure by patient groups in the three months preceding the survey in 2020, Cambodia

Table S1 shows the arithmetic mean of healthcare expenditure (Annexure 4). The arithmetic mean is the mean before the data log-transformation. Since our model's Risk Ratio (RR) in Table 4 is the geometric mean (after log-transformation) ratio, we presented the geometric mean in Table S2 (Annexure 4). 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 5 presents results from multiple linear regression. 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 risk ratio (ARR) of 0.7 [95% CI 0.5–0.8], P -value<0.001). The same association was seen in people with HTN (ARR of 0.8 [95% CI 0.6–1.0], P -value<0.01), and in T2D plus HTN (ARR of 0.3 [95% CI 0.2–0.6], 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 0.2–0.3], P -value<0.001). The association was also found in people with HTN (ARR 0.4 [95% CI 0.3–0.5], 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 1.1–3.8], P -value<0.01) than those with *hospital-based care*.

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

Variable	Overall [N=2142]	No T2D/HTN [N=1187]	HTN [N=726]	T2D [N=98]	T2D plus HTN [N=139]
	ARR [95% CI]	ARR [95% CI]	ARR [95% CI]	ARR [95% CI]	ARR [95% CI]

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

(*) P -value<0.05, (**) P -value<0.01, (***) P -value<0.001

Abbreviation: ARR, adjusted risk ratio; CI: confidence interval; Ref., reference group; OD, operational district

Note: Health center-based (high) means the OD with high coverage (six out of nine) of health centers with the WHO

PEN; Health center-based (low) means the OD with low coverage (six out of 25) of health centers with the WHO

PEN; P -values<0.05, <0.01, <0.001 are in bold, indicating the variables are significantly associated with expenditure

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.²¹ 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.⁸ 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.²⁵ Our findings suggest that healthcare quality and access to public healthcare services is still below the expectations of people. To increase public healthcare utilization, efforts need to be made to expand the coverage and quality of T2D and HTN services in public healthcare facilities. However, this may require time and resources, which will have budget implications, while Cambodia may not be able to increase the budget for health more than its economic growth rate of about 7% per year.²⁶ Another approach could be to recognize the role of private healthcare providers and include them in the coverage schemes. This would mean that they are required to

comply with government policies and regulations. The practical, financial, legal, and political implications of such strategies need to be examined.

Previous studies revealed that HEF membership contributed to the health service uptake at public facilities and reduced healthcare expenditure in general users.^{16 27} Our findings extended the understanding 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. These findings suggest that HEF membership should be expanded among people with chronic conditions, alongside with improving service coverage and quality. By doing so, the health services with quality for people with T2D and/or HTN will be more accessible with fewer financial barriers.

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, PEs refer patients to the public referral hospitals, so it is not surprising that the public service uptake is slightly higher than other ODs.²⁸ 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. This may be 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 unit costs were higher for T2D and HTN patients in the *community-based care* than the *hospital-based care* (USD 101 vs. USD 77 for a T2D patient and USD 83 vs. USD 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. 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.²² 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 between different care models and cost-effectiveness remains the gap in Cambodia and should be conducted for a better decision.

There are several strengths in our study. First, our study is among the few to examine healthcare utilization and expenditure both among people with T2D and/or HTN and people without the two conditions. 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 with different care models and geographically dispersed, which means that our participants are heterogeneous. 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 utilization 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 three months preceding the survey, which cannot be generalized to the target population in the study (people aged 40 years or older).

However, it is unlikely to be significant because we focused more on factors associated with increasing or reducing healthcare expenditure. Fourth, the sample size may be relatively small when we stratified them into four groups. Therefore, variables that were not significantly associated with the dependent variables in our study may be due to the insufficient sample size.

CONCLUSION

Healthcare utilization 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 utilization in people with chronic conditions. Using public healthcare services regardless of HEF status reduced the healthcare expenditure, but the reduction in spending was more noticeable in people with HEF membership. To increase public healthcare utilization among people with T2D and/or HTN, the public healthcare system should further improve care quality, expand social health protection, and expand community-based care for this population. However, these may require more time and resources. One potential strategy in the short run is to partner the private sector with the public sector. 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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CONFLICT OF INTERESTS

All authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

SC, PI, VT, EW designed the study; SC analyzed data; all authors wrote the manuscript.

DATA AVAILABILITY STATEMENT

Data are available on reasonable request. Data are available on reasonable request to Dr. Por Ir (ipor@niph.org.kh).

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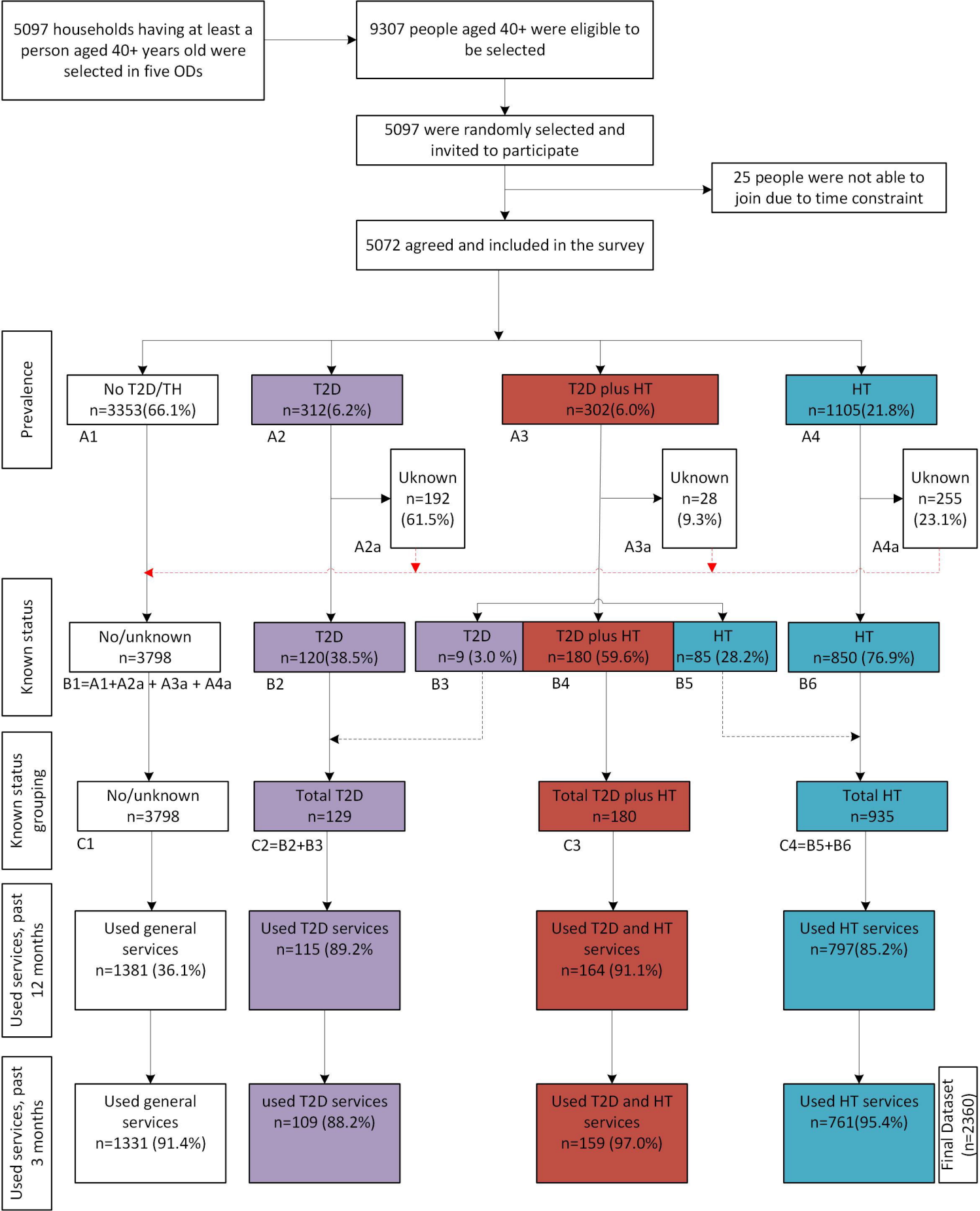
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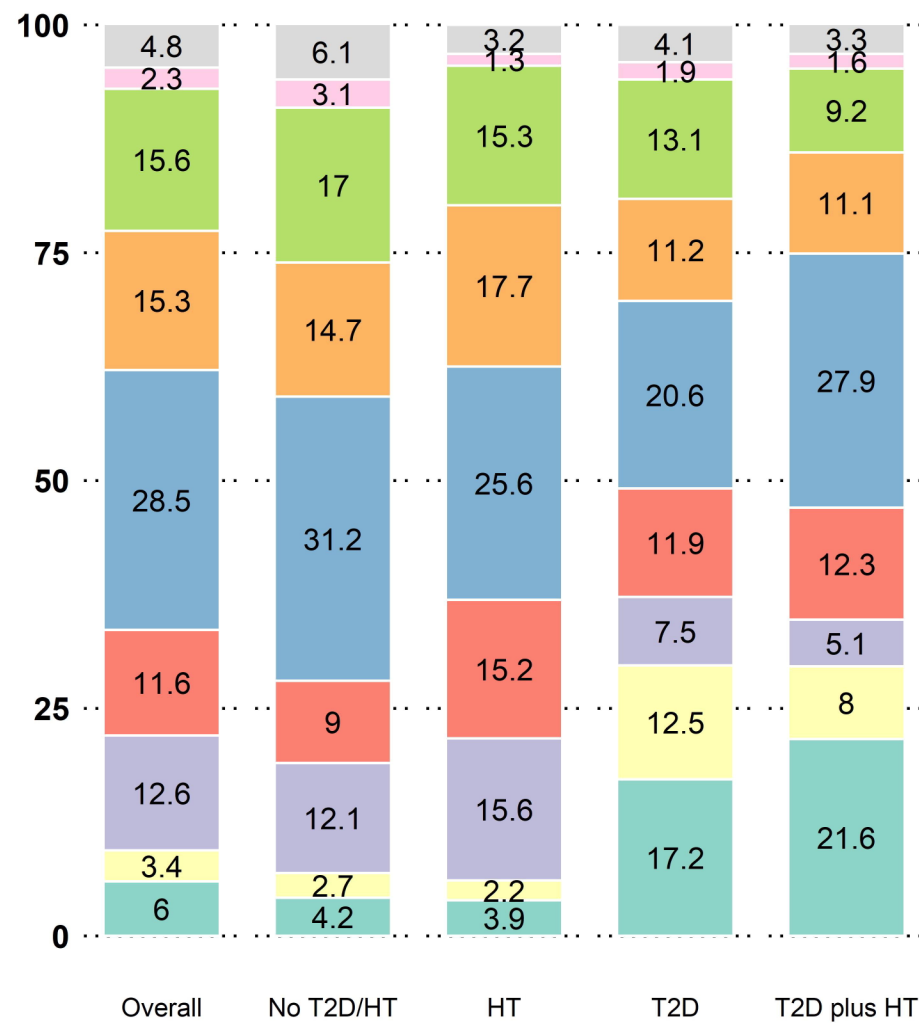
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618



A. Proportion of visits by health facility



B. Proportion of visits by sector

