**Representation of the Human Resources Capabilities in the HealthSystem Module**

We provide a model representation and comprehensive description for Malawi healthcare system and human resources. In this document, we first introduce important data and document sources, then describe the healthcare system and human resources from four aspects:

* Healthcare system organisation (definitions of facility level and referral between levels);
* Health service types and time requirements;
* The allocation of healthcare workers to facilities and the available time (patient facing time) for providing services for each healthcare worker type;
* The consequent total minutes of healthcare worker time available (daily capabilities) to provide services.

# 0. Sources

The predominant dataset used for the description is the *Malawi Human Resources for Health Strategic Plan (HRH SP) 2018-22* and *Government of Malawi: Health Sector Strategic Plan II (HSSP II) 2017-2022* [[1, 2]](#_Bibliography). The data[[1]](#footnote-1) underlying these reports provide information of health facility types, health worker cadres, and health service appointments, and data of current and established[[2]](#footnote-2) staff count, service time requirements, available working time for cadres, and health service delivery counts for year 2016.

# 1. Healthcare System and Facility Levels

The reports of *Malawi Human Resources for Health Strategic Plan (HRH SP) 2018-22* and *Government of Malawi: Health Sector Strategic Plan II (HSSP II) 2017-2022* describe that health services in Malawi are delivered through a four-tier system. Community level services are accessed at health posts and directly provided by health surveillance assistants (HSA[[3]](#footnote-3)) and other community-based workers. Primary level services are accessed at health centres and community hospitals. Secondary level services are accessed at district hospitals and CHAM hospitals of equivalent capacity, which also provide referral services to health centres and community hospitals. Tertiary level services are accessed at central hospitals that provide specialist health services at regional level and referral services to district hospitals within that region. Besides, there are district health offices (DHO) managing and directing provision of primary and secondary level facilities, and Ministry of Health Headquarters with functions including policy making, standards setting, strategic planning, resource mobilization, etc. [[1, 2]](#_Bibliography)

On this basis, we define a facility level system (Table 1).

Table 1: Malawi Healthcare System and Facility Level

|  |  |  |  |
| --- | --- | --- | --- |
| **Facility Level** | **Description** | **Facility Types[[4]](#footnote-4)** | **Number** |
| 0 | Facilities provide service at local level and have little infrastructure | Health Post, Village Health Committee, Community Health Station, Village/Mobile/Outreach Clinic, and other community initiatives | One set per district |
|  |
|  |
| 1a | Facilities provide services at primary level but have less capacity than hospitals | Dispensary, Rural/Urban Health Centre, Private/Special/Antenatal Clinic, Maternity Clinic/Facility | One set per district |  |
|  |
|  |
|  |
| 1b | Hospitals provide services at primary level | Community/Rural Hospital, CHAM (community) Hospital | One set per district |  |
|  |
|  |
| 2 | Facilities provide services at district level and provide referral services to primary level facilities | District Hospital, District Health Office | One set per district |  |
|  |
| 3 | Central hospitals provide specialist health services at regional level and provide referral services to district level facilities in that region | Kamuzu Central Hospital (KCH, Central), Mzuzu Central Hospital (MCH, North), Zomba Central Hospital (ZCH, South) & Queen Elizabeth Central Hospital (QECH, South) | One set per region |  |
| 4 | National level resource hospitals and centres | Zomba Mental Hospital (ZMH) | One set |  |
| 5 | Ministry of Health Headquarters | Headquarters | One set |  |

We note the following simplifying assumptions:

* We divide primary level into two sublevels, which differentiate between health centres (level 1a) and community hospitals (level 1b). This is because community hospitals are larger than health centres and conduct minor procedures in addition to outpatient and inpatient services. [[2]](#_Bibliography)
* We define CHAM hospitals as being at the same level as community hospitals (level 1b)[[5]](#footnote-5).
* We define a level (level 4) for facilities that are national resources (to where patients from the entire can be referred). The only facility in this level is Zomba Mental Hospital.

In Table 1 we also specify the number of facilities for each level. Each district in Malawi has its own sets of level 0, level 1a, level 1b and level 2 facilities. Each region (North, Central, South) has its own set of level 3 facilities (central hospitals), called “Referral Hospital - Northern/Central/Southern” to differentiate with “Central Hospital”. Therefore, Malawi has *4D + 5* facility sets in total (including Headquarters), where D is the number of districts. The full list of facility sets is provided by *ResourceFile\_Master\_Facilities\_List.csv[[6]](#footnote-6)*.

We assume that resource and capabilities are pooled within the district for levels 0, 1a, 1b and 2. Level 2 facilities provide referral services to level 1a and level 1b facilities. Level 3 facilities provide referral services to lower-level facilities in that region (comprising many districts). Level 4 facilities provide referral services to lower-level facilities in all regions. Table 2 below explains the patterns using examples of Districts 1 - 6.

Table 2: Heath Facility Catchment and Referral Patterns

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Facility Level = 4, 5 | National level facilities and MOH headquarters | | | | | |
| Facility Level = 3 | MCH [Referral Hospital - Northern region] | | KCH [Referral Hospital - Central region] | | ZCH & QECH [Referral Hospital - Southern region] | |
| Facility Level = 2 | Second level facilities [District 1] | Second level facilities [District 2] | Second level facilities [District 3] | Second level facilities [District 4] | Second level facilities [District 5] | Second level facilities [District 6] |
| Facility Level = 1a, 1b | Primary level facilities [District 1] | Primary level facilities [District 2] | Primary level facilities [District 3] | Primary level facilities [District 4] | Primary level facilities [District 5] | Primary level facilities [District 6] |
| Facility Level = 0 | Local level facilities [District 1] | Local level facilities [District 2] | Local level facilities [District 3] | Local level facilities [District 4] | Local level facilities [District 5] | Local level facilities [District 6] |

# 2. Healthcare Services

## 2.1 Appointments and Categories

There are 48 types of health service activities, called “appointments”, summarised in the source data.

We notice that health service delivered by cadre DCSA are not included in these data, thereby *assuming* a unique appointment type as below:

* We define the appointment “ConWithDCSA” for cadre DCSA.

We generate *ResourceFile\_Appt\_Types\_Table.csv* listing 49 appointment types, as shown in Table 3.

Table 3: Appointment Types Table

|  |  |
| --- | --- |
| **Appt\_Type\_Code** | **Appt\_Type** |
| InpatientDays | Inpatient Admissions (Ongoing Monitoring) |
| IPAdmission | Inpatient Admissions and Discharge Process |
| Under5OPD | Under 5 Outpatient Visit |
| Over5OPD | Over 5 Outpatient visit |
| NormalDelivery | Normal Deliveries |
| CompDelivery | Complicated Deliveries |
| Csection | Caesarean Sections |
| FamPlan | Family Planning |
| AntenatalFirst | Antenatal Care - First Visit |
| ANCSubsequent | Antenatal Care - Followup Visit |
| EPI | EPI |
| STI | STI |
| U5Malnutr | Treatment of U5 Severe Malnutirion |
| AccidentsandEmerg | Accidents and Emergencies |
| MajorSurg | Major Surgical Procedures |
| MinorSurg | Minor Surgical Procedures |
| TBNew | TB Program - New Patient |
| TBFollowUp | TB Program - Follow-up Patient |
| VCTNegative | Voluntary Counseling and Testing Program - For HIV-Negative |
| VCTPositive | Voluntary Counseling and Testing Program - For HIV-Positive |
| MaleCirc | Male Circumscisions |
| NewAdult | HIV/AIDS Program - New Adult |
| EstMedCom | HIV/AIDS Program - Established Medically Complex |
| EstNonCom | HIV/AIDS Program - Established Non Medically Complex |
| PMTCT | HIV/AIDS Program - PMTCT |
| Peds | HIV/AIDS Program - Pediatric |
| LabHaem | Laboratory - Haematology |
| LabPOC | Laboratory - POC |
| LabParasit | Laboratory - Parasitology |
| LabBiochem | Laboratory - Biochemistry |
| LabMicrobio | Laboratory - Microbiology |
| LabMolec | Laboratory - Molecular |
| LabTBMicro | Laboratory - TB Microscopy |
| LabSero | Laboratory - Serology |
| LabCyto | Laboratory - Cytology |
| LabTrans | Laboratory - Blood Transfusion Lab Analysis |
| Ultrasound | Ultrasound |
| Mammography | Mammography |
| MRI | MRI |
| Tomography | Tomography |
| Radiotherapy | Radiotherapy |
| DiagRadio | Diagnostic Radiography Procedures |
| DentAccidEmerg | Dental Accidents and Emergencies |
| DentSurg | Dental Surgical Procedures |
| DentalU5 | Dental under 5 outpatient visits |
| DentalO5 | Dental over 5 outpatient visits |
| MentOPD | Mental Health OPD |
| MentClinic | Mental Health Clinic Visit |
| ConWithDCSA | ConWithDCSA |

## 2.2 Appointment Time Requirement

The sheet ‘Time\_Base’ in the source data specifies the time requirement for the appointment types. Specifically, for each cadre and each appointment, we are informed of *minutes* required for that cadre to deliver that appointment service and *percentage* of that appointment requires the minutes of that cadre. The minutes and percentages are different at different facility types, which include central hospital, district hospital, community hospital, urban health centre, rural health centre, dispensary, and health post.

We calculate the *expected time* for each cadre that is required by each appointment type, by multiplying the *minutes* with *percentages[[7]](#footnote-7)*. The source data do not provide time requirements of appointments for all possible facility types at all levels. We therefore *assume* the following:

* We estimate the service time requirement for “ConWithDCSA” is 10 minutes paired with 100% percentage[[8]](#footnote-8); thus, the expected time of “ConWithDCSA” at level 0 is 10 minutes.
* We calculate the average of the expected time at rural health centre and urban health centre to represent the time requirement for each cadre and each appointment at level 1a.
* We use the expected time at community hospital to represent time requirement for each cadre and each appointment at level 1b.
* We use the expected time at district hospital to represent time requirement for each cadre and each appointment at level 2.
* We use the expected time at central hospital to represent time requirement for each cadre and each appointment at level 3.
* We use the relevant expected time at central hospital to represent time requirement for appointments “Mental Health OPD” and “Mental Health Clinic Visit” and cadre “Mental Health Staff” at level 4 / ZMH.

This process results in the time table for each cadre (or officer type) and each appointment at levels 0 to 4. We further sum up the time requirements for each officer category and each appointment at each level, which can be found in *ResourceFile\_Appt\_Time\_Table.csv*[[9]](#footnote-9).

## 2.3 Appointment Types by Facility Level

It should be noted that not all appointments can be served at each level, thus appointment types happening at each level vary from each other. It is useful to get explicit information of what appointment happens at what level. Therefore, with reference to the appointment time table, we generate *ResourceFile\_ApptType\_By\_FacLevel.csv* that indicates whether one of the 49 appointments type occurs at one of the 7 levels with True or False value[[10]](#footnote-10).

# 3. Healthcare Workers

## 3.1 Cadres and Categories

There are defined 21 types of healthcare worker cadres, that fall into 9 categories (Table 4).

Table 4: Cadres and Categories (*ResourceFile\_Officer\_Types\_Table.csv*)

|  |  |  |
| --- | --- | --- |
| **Officer\_Type** | **Officer\_Type\_Code** | **Officer\_Category** |
| Medical Officer / Specialist | M01 | Clinical |
| Clinical Officer / Technician | M02 | Clinical |
| Med. Assistant[[11]](#footnote-11) | M03 | Clinical |
| Nurse Officer | N01 | Nursing\_and\_Midwifery |
| Nurse Midwife Technician | N02 | Nursing\_and\_Midwifery |
| Pharmacist | P01 | Pharmacy |
| Pharm Technician | P02 | Pharmacy |
| Pharm Assistant | P03 | Pharmacy |
| Lab Officer | L01 | Laboratory |
| Lab Technician | L02 | Laboratory |
| Lab Assistant | L03 | Laboratory |
| DCSA | E01 | DCSA |
| Dental Officer | D01 | Dental |
| Dental Therapist | D02 | Dental |
| Dental Assistant | D03 | Dental |
| Mental Health Staff | C01 | Mental |
| Nutrition Staff | T01 | Nutrition |
| Radiographer | R01 | Radiography |
| Radiography Technician | R02 | Radiography |
| Sonographer | R03 | Radiography |
| Radiotherapy Technician | R04 | Radiography |

Due to missing data, there are a few cadres not included in this report, such as Education/Environment health officer, Home Craft Worker, Community Midwifery Assistant and Community Health Volunteers. [[1]](#_Bibliography)

## 3.2 Current and Funded Staff Distribution

The ‘CurrentStaff’ sheet in the source data has provided staff counts for each cadre in 28 districts (including Likoma), 4 central hospitals and Headquarters in both current and funded scenarios. This gives us information of number of staff per cadre at level 2 and below, level 3 and level 5. However, staff distributions at levels 0, 1a, 1b and 2, as well as level 4/Zomba Mental Hospital, are not available. Moreover, staff counts in 4 special districts including Lilongwe City, Mzuzu City, Zomba City and Blantyre City are not explicitly provided, and the special district Likoma only has some establishment staff counts recorded.

To reasonably estimate staff distributions at each defined level in all Malawi districts, we need to make the following *assumptions* forboth current and funded scenarios:

* We assume the 5 special districts Likoma, Lilongwe City, Mzuzu City, Zomba City and Blantyre City are respectively included in Nkhata Bay, Lilongwe, Mzimba, Zomba and Blantyre among the 27 general districts[[12]](#footnote-12). We then split the staff from each of the general district to the special district according to population proportions[[13]](#footnote-13) in the two districts. (Note that in establishment scenario, the source data provide staff counts of multiple cadres (except DCSA) for Likoma.)
* We assign all DCSAs to level 0 facilities since DCSAs mainly provide health services in villages and communities[[14]](#footnote-14), and assume that DCSA is the only cadre at level 0.
* We calculate staff proportions among levels 1a, 1b and 2 using available data from CHAI Compiles Staff Return for current staff, and from CHAI Facility-level establishment for funded staff. We then assign staff (except DCSAs) from a district to levels 1a, 1b and 2 based on the calculated staff proportions[[15]](#footnote-15).

The complete current and funded staff assigned to all levels and all districts can be found in *ResourceFile\_Staff\_Table.*csv in the current and funded scenarios. In the exemplar result below (Table 5) for funded staff, 7 M01 officers in Balaka district are divided to 3 for level 1b and 4 for level 2; all E01/DCSA officers in Balaka are assigned to level 0 as assumed; and Zomba Mental Hospital has three mental health staff/C01 allocated.

Table 5: Exemplar Results of Funded Staff Distribution[[16]](#footnote-16)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **District\_Or\_Hospital** | **Facility\_Level** | **M01** | **E01** | **C01** |
| Balaka | Facility\_Level\_0 | 0 | 250 | 0 |
| Balaka | Facility\_Level\_1a | 0 | 0 | 0 |
| Balaka | Facility\_Level\_1b | 3 | 0 | 0 |
| Balaka | Facility\_Level\_2 | 4 | 0 | 0 |
| Referral Hospital\_Central | Facility\_Level\_3 | 303 | 0 | 12 |
| Referral Hospital\_Northern | Facility\_Level\_3 | 217 | 0 | 10 |
| Referral Hospital\_Southern | Facility\_Level\_3 | 552 | 0 | 16 |
| Zomba Mental Hospital | Facility\_Level\_4 | 0 | 0 | 136 |

## 3.3 Funded Plus Scenario for Staff Distribution

Given the results of funded staff distribution in [Section 3.2](#_3.2_Current_and), we observe that all district mental health staff are allocated to level 1b, and that 7 general districts (Balaka, Machinga, Mwanza, Neno, Nkhata Bay, Ntchisi, Salima) have zero mental health staff, whereas the appointment time requirements imply that this cadre is also needed at and above level 2; also, Likoma has no DCSA staff to provide services at level 0. For the consistency of appointment demand and staff supply at each level, we make three additional *assumptions* as follows:

* We split the DCSA staff from Nkhata Bay to Likoma using their populations as weights;
* We move 1 mental health staff to each of the 7 district from their regional hospitals, respectively;
* We use the estimates for optimal workforce in the auxiliary source data to calculate the proportions of mental health staff at level 1b and level 2 (i.e. 47.92\% and 52.08\%, rather than 100\% and 0\% in the establishment scenario) and re-split the staff within each district to level 1b and level 2.

This process results in another scenario of funded staff distribution, called ‘funded plus’, in addition to the current and funded scenarios in [Section 3.2](#_3.2_Current_and).

## 3.4 Patient Facing Time

For each of 21 cadres, the sheet ‘PFT’ in the source data provides their *working days per year* and *working hours per day* that are available for delivering patient-facing services, accounting for leave, sickness and non-productive days and hours. The working days per year are recorded for male, female, and pregnant female staff separately, with male/female/pregnant female staff proportions specified; the working hours per day are recorded for staff at hospitals and health centres individually. (Note that in the source data the patient facing times for clinical, nursing and midwifery, pharmacy and laboratory cadres for fully validated estimates for Malawi, whereas those for DCSA, Dental, Mental and Radiography cadres are estimates from the previous cadres or countries of Eswatini and Zambia.)

With reference to the source data, we generate a patient facing timetable considering following variables for each cadre:

* *Weighted average working days per year* among male, female, and pregnant staff.
* *Patient facing hours per day* at hospitals and health centres, equal to the working hours per day in the source data.
* *Average patient facing minutes per day* at hospitals and health centres, calculated via the formula as we *assume* the total productive minutes are distributed evenly over the year.

The results can be found in *ResourceFile\_Patient\_Facing\_Time.csv*.

# 4. Staff Daily Capabilities

## 4.1 Current and Funded Staff Daily Capabilities

With the availability of current and funded staff distributions and patient facing time in [Section 3](#_3._Healthcare_Workers), we now calculate the daily capabilities for each officer category at each facility set, which is associated with level and district information as defined in [Section 1](#_1._Healthcare_System).

Consider that each current and funded staff is assigned to a facility level as well as a facility set, but the patient facing time are explicitly provided only for hospitals and health centres rather than for each level. According to the level definitions, we make the following *assumptions*:

* We use patient facing minutes per day at health centres to represent the minutes of staff at level 0 and level 1a.
* We use patient facing minutes per day at hospitals to represent the minutes of staff at level 1b and above (Specifically, ComHos to level 1b, DisHos to level 2, level 3 and level 4).

Subsequently, by assigning the patient facing minutes of each cadre at each facility level to each current and funded staff, i.e., multiplying the patient facing minutes with the staff counts for each cadre at each level and then grouping by officer categories, we obtain the daily capabilities of each officer category at each facility set for both current and funded scenarios.

The complete results can be found in *ResourceFile\_Daily\_Capabilities.csv*[[17]](#footnote-17) in current and funded scenarios. Table 6 below gives some exemplar results of funded staff daily capabilities.

Table 6: Exemplar Results of Funded Staff Daily Capabilities

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Facility\_ID** | **Facility\_Name** | **Region** | **Officer\_Category** | **Total\_Mins\_Per\_Day** |
| 0 | Facility\_Level\_0\_Balaka | Southern | DCSA | 13957.01 |
| 1 | Facility\_Level\_1a\_Balaka | Southern | Dental | 2327.32 |
| 2 | Facility\_Level\_1b\_Balaka | Southern | Clinical | 9786.98 |
| 3 | Facility\_Level\_2\_Balaka | Southern | Clinical | 13915.91 |
| 128 | Referral Hospital\_Southern | Southern | Clinical | 170795.67 |
| 129 | Referral Hospital\_Northern | Northern | Dental | 3268.32 |
| 130 | Referral Hospital\_Central | Central | Laboratory | 18825.50 |
| 131 | Zomba Mental Hospital |  | Mental | 27780.76 |

## 4.2 Funded Plus Scenario for Staff Daily Capabilities

Similar to [Section 4.1](#_4.1_Current_and), we assign the patient facing minutes of each cadre at each level to each staff in the funded plus scenario and then obtain the staff daily capabilities. According to the additional assumptions in [Section 3.3](#_3.3_Funded_Plus), we know that there are only capability differences for the mental health staff category (and DCSA cadre for Likoma) between the funded and funded plus scenarios, as evidenced by the tables of *ResourceFile\_Daily\_Capabilities.csv.* Below (Table 7) is an exemplar result showing such difference.

Table 7: Exemplar Differences of Daily Capabilities in Funded and Funded Plus Scenarios

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Facility\_ID** | **Facility\_Name** | **Cadre\_Category** | **Funded: Total\_Mins\_Per\_Day** | **Funded Plus:**  **Total\_Mins\_Per\_Day** |
| 6 | Facility\_Level\_1b\_ Blantyre | Mental | 204.27 | 97.89 |
| 7 | Facility\_Level\_2\_ Blantyre | Mental | 0 | 106.38 |
| 40 | Facility\_Level\_0\_ Likoma | DCSA | 0 | 712.21 |

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[5] Government of Malawi, Ministry of Health and Population, 2019. Malawi Harmonized Health Facility Assessment (HHFA) 2018-2019 Report: District Profiles (English). Washington, D.C.: World Bank Group. <http://documents.worldbank.org/curated/en/552991611645542004/Malawi-Harmonized-Health-Facility-Assessment-HHFA-2018-2019-District-Profiles>

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[8] World Bank Group , 2020. Closing the Gap: Why Achieving Universal Health Coverage in Malawi Now Requires Targeted Investment in Underperforming and Underserved Districts (English). Policy Brief Washington, D.C.: World Bank Group. <http://documents.worldbank.org/curated/en/482201611638301118/Closing-the-Gap-Why-Achieving-Universal-Health-Coverage-in-Malawi-Now-Requires-Targeted-Investment-in-Underperforming-and-Underserved-Districts>

[9] World Bank Group , 2020. Harnessing Momentum: Priority Areas of Intervention to Further Strengthen Malawi’s Health Sector (English). Policy Brief Washington, D.C.: World Bank Group. <http://documents.worldbank.org/curated/en/108221611566167934/Harnessing-Momentum-Priority-Areas-of-Intervention-to-Further-Strengthen-Malawi-s-Health-Sector>

[10] World Health Organization, 2010. *Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies*. World Health Organization. <https://apps.who.int/iris/bitstream/handle/10665/258734/9789241564052-eng.pdf>

# Appendix

Below is a list of output resource files in the [TLOmodel package](https://github.com/UCL/TLOmodel/tree/master/resources).

|  |  |
| --- | --- |
| **Path**  (./resources/healthsystem/human\_resources/) | **Table** |
| organisation/ | ResourceFile\_Master\_Facilities\_List.csv |
| definitions/ | ResourceFile\_Officer\_Types\_Table.csv |
| ResourceFile\_Appt\_Types\_Table.csv |
| ResourceFile\_Appt\_Time\_Table.csv |
| ResourceFile\_ApptType\_By\_FacLevel.csv |
| actual/ | ResourceFile\_Daily\_Capabilities.csv |
| funded/ | ResourceFile\_Daily\_Capabilities.csv |
| funded\_plus/ | ResourceFile\_Daily\_Capabilities.csv |

Other tables that can be generated include:

* Scenario 'actual': ResourceFile\_Staff\_Table; ResourceFile\_Staff\_Distribution\_Assumption
* Scenario 'funded': ResourceFile\_Staff\_Table; ResourceFile\_Staff\_Distribution\_Assumption
* ResourceFile\_Staff\_Distribution\_Compare
* ResourceFile\_Patient\_Facing\_Time
* ResourceFile\_District\_Population\_Data
* ResourceFile\_Facilities\_For\_Each\_District

1. The source data are provided to us for use as a set of files: ‘ORIGINAL\_Optimization model

   import\_Malawi\_20180315 v10.xlsx’, ‘CHAI Compiled Staff Returns.xlsx’, ‘CHAI 2018-03-09 Facility-level

   establishment MOH & CHAM.xlsx’, ‘ CHAI MalawiOptimization\_OUTPUT\_ALLYEARS\_Curr’ (Estimates of

   immediately needed workforce), and ‘CHAI MalawiOptimization\_OUTPUT2022 SH 2019-10-19’ (Estimates of

   optimal workforce). [↑](#footnote-ref-1)
2. “Established staff” and “Funded staff” are used interchangeably in this report. In Malawi, establishment staff counts include all positions that are intended to be present by the government, irrespective of vacancies. [↑](#footnote-ref-2)
3. HSAs are also classified as Disease Control and Surveillance Assistants (DCSAs). [[1]](#_Bibliography) [↑](#footnote-ref-3)
4. These facility types are collected from HRH SP 2018-22, HSSP II [[2]](#_Bibliography) , Word Bank Report [[3]](#_Bibliography), HHFA Report [[4]](#_Bibliography),

   and experts’ information. [↑](#footnote-ref-4)
5. In the source data, all CHAM hospitals all categorised as community hospitals. Also, CHAM hospitals do not

   provide referral services to health centres and community hospitals as district hospitals do according to

   experts’ advice. [↑](#footnote-ref-5)
6. All output files are named after ‘ResourceFile’ and are listed in [Appendix](#_Appendix). [↑](#footnote-ref-6)
7. These data indicate that for an appointment, in some cases one cadre is required and in other cases another

   cadre is required. In order to service any eventuality in the course of an appointment, we therefore interpret

   that both cadres are required but with the expected time used for each cadre. [↑](#footnote-ref-7)
8. We make this estimate by consulting with experts. [↑](#footnote-ref-8)
9. This table considers officer categories and is derived from the time table considering officer types. [↑](#footnote-ref-9)
10. Note that time tables of officer categories and officer types produce the same table of appointment types by

    facility level, and that since Headquarters have no appointment type or time requirement data, values at

    level 5 are all False in default. [↑](#footnote-ref-10)
11. Medical Assistant. We use “Med. Assistant” to be consistent with all relevant the source datasets. [↑](#footnote-ref-11)
12. In this report, we consider all 32 districts (27 general + 5 special) in 2018 Malawi Census, i.e., D = 32. [↑](#footnote-ref-12)
13. The population data are in *ResourceFile\_District\_Population\_Data.csv*, generated using

    *ResourceFile\_PopulationSize\_2018Census.csv*. [↑](#footnote-ref-13)
14. Experts indicate that DCSAs may sometimes do vaccination clinics or other work at level 1a facilities. [↑](#footnote-ref-14)
15. The proportions are provided in *ResourceFile\_Staff\_Distribution\_Assumption.csv*. We have further compared

    the calculated proportions with CHAI estimates for optimal workforce and immediately needed staff, which

    can be referred to *ResourceFile\_Staff\_Distribution\_Compare.csv*. [↑](#footnote-ref-15)
16. Staff counts in this table have been rounded to the nearest integers. [↑](#footnote-ref-16)
17. These tables consider officer categories and are derived from capability tables considering officer types. [↑](#footnote-ref-17)