Public Sector Radiological Resources and Utilization Patterns in the Western Cape Province of South Africa

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Abstract

Background There are marked disparities in radiological resources globally, particularly between metropolitan and rural populations. The World Health Organization (WHO) suggests that 90% of low- and middle-income country (LMIC) imaging needs can be addressed by one X-ray and ultrasound machine for every 50000 people. However, this figure is untested, as limited work on radiological resources and service utilization patterns globally, particularly in LMICs exists. The aim was to analyze provincial radiological service in a middle-income country.

Methods An institutional review board-approved retrospective audit of radiological data for the public healthcare sector of the Western Cape Province (WCP) of South Africa (SA) for 2017, utilizing databases of the WCP Department of Health and Stats SA. We conducted population-based analyses of imaging equipment, personnel, and service utilization data for the province, metropolitan and rural areas.

Results Metropolitan population density exceeds rural (1682 vs 19 people/km²; 89:1). Rural imaging facilities by population are double the metropolitan (19 vs 11/10 6 people). Provicially, there are 36 X-ray and 18 ultrasound units/10 6 people. Rural X-ray (39.3 vs 33.6/10 6 people), ultrasound (24.7 vs 14.5/10 6 people) and mammography (14 vs 5 units/10 6 women > 40 years) resources exceed metropolitan by 17, 70 and 180 percent, respectively. Metropolitan personnel resources by population (n = 112 vs 53/10 6 people) and equipment unit (1.7 vs 0.7/10 6 people) are double the rural. Provincial imaging studies totalled 1.2778 million, averaging 262 examinations/10 3 people and 1.3 investigations/patient. Radiography (n=935607,73%) and ultrasound (n=202639,16%) together constituted 89% (n=1138246) of studies. Population-based utilization of imaging services was 30% higher in the metropole (279 vs 214 studies/10 3 people), with mammography (24 vs 5 studies/10 3 woman > 40 years; 517%) and CT (21 vs 6/10 3 people; 380%) recording the highest differentials and plain radiography (203 vs 171/10 3 people; 19%) the lowest.

Conclusion Our findings support the WHO contention that approximately ninety percent of a population’s diagnostic imaging needs can be met by plain radiography and ultrasound and underscore the complexity of achieving equitable utilization of services between rural and metropolitan areas.

Background

Diagnostic imaging is currently recognised as a key building block of any healthcare system and is considered essential for effective primary health care.(1–10) However, radiological services are expensive, labour-intensive, require high levels of technical expertise and are thus amongst the leading drivers of escalating medical costs. (11–15)

The expense of modern diagnostic imaging has the potential to compound existing worldwide inequalities in access to radiological services. At one end of the spectrum are high-income countries with an aging population, a high burden of non-communicable diseases and a relative abundance of radiological resources. (11,16) At the other end are more than half the world's population, living in low- and
middle-income countries (LMIC) by World Bank criteria, with diseases predominantly related to poverty, and with only limited access to basic imaging resources. There are marked disparities in radiological equipment resources amongst countries in the same World Bank economic grouping, as well as between geographical regions and healthcare sectors within the same country. The greatest divide is between metropolitan and rural populations. (5,9,17−23)

The reduction of inequality and the promotion of universal health coverage are two key United Nations 2030 Sustainable Development Goals (SDGs). (18) The World Health Organization (WHO) suggests that approximately ninety percent of all LMIC imaging needs can be addressed by one plain radiographic unit and a basic ultrasound machine for every 50,000-100,000 people, or 20 units each per million people. However, this figure is untested, as there has been limited in-depth work on radiological resources and service utilization patterns globally, particularly in LMICs. Although the WHO has published national estimates of high-end medical imaging resources based on questionnaire surveys of member countries, these data do not include basic equipment such as plain radiography and ultrasound units. (24) Furthermore, while Stellenbosch University in Cape Town, South Africa, is coordinating a project to collate detailed data on registered radiological resources in Southern, East and West Africa, these data do not include ultrasound equipment, or utilization data. (17,22,23,25) Despite the European Commission conducting detailed surveys of the use of ionizing radiation for medical purposes, data are not correlated with imaging equipment and personnel resources. (26) Although there has been an analysis of differential geographical utilization of radiological services in Norway, (27) the need exists for such an analysis in LMICs, incorporating all components of the so-called “imaging enterprise”. (14) The healthcare infrastructure of the Western Cape Province (WCP) of South Africa (SA) is ideal for such an analysis.

SA is one of five upper middle-income countries in sub-Saharan Africa. It has adopted the District Health System (DHS) for delivery of comprehensive primary care to its peoples. (28) Health services are devolved to the country’s nine provinces. The WCP is SA’s southernmost province. It has six administrative districts. The City of Cape Town Metropolitan District is surrounded by five sprawling rural Districts (Fig. 1), (29) in which the main economic activities are agriculture and recreation.

WCP health services, including diagnostic imaging, are managed along geographic lines, and stratified as metropolitan or rural streams. (30) Mirrored, tiered referral pathways exist in each system. First access to imaging is generally at Community Day Centres or Community Health Centres with sequential referral to District, Regional, and Central Hospitals, the latter being university-affiliated tertiary-level teaching institutions.

The WCP has a provincial-wide digital imaging platform, with picture archiving and communication system (PACS)-integration of services at the various levels of care. This facilitates access to all imaging across the platform and eliminates unnecessary duplication of services. Clinicians at lower tiers of service can also get assistance in interpretation of investigations via the digital platform.
The Medical Imaging Services Sub-Directorate within the Directorate of Health Technology in the WCP Department of Health (DoH) is responsible for stringent collation of all data pertaining to provincial imaging, including the number and location of all radiological equipment units and personnel, as well as the utilization of services at each facility. These public sector data provide unique insights into the utilization of imaging services in a high middle-income country.

The aim of this study was to analyse the resources and utilization patterns of the WCP radiological platform, including those features differentiating metropolitan from rural services.

**Methods**

This was a retrospective audit of diagnostic imaging data for the public healthcare sector of the WCP of SA for 2017. All radiological details were extracted from the databases of the Medical Imaging Services Sub Directorate of the Directorate of Health Technology of the WCP DoH. Population and demographic particulars were based on Stats SA District Council Projections for 2017. (28)

Data on radiological equipment units and examinations performed were captured on a customized spreadsheet and stratified by imaging modality, healthcare facility and provincial service stream (metropolitan/rural). Plain radiography and fluoroscopy units were further subdivided into fixed and mobile units. Plain radiographic examinations were categorised as chest radiographs (CXR) and general radiographs (GR). All analyses were for the province as a whole and for the metropolitan and rural areas.

The number of radiology equipment units per million people was calculated by modality. The quantum of radiological examinations for each modality was assessed per thousand people, as well as per thousand patient engagements. Imaging examinations per equipment unit were calculated by modality.

The numbers of registered personnel in the categories of diagnostic radiographer, sonographer, registrar, and radiologist were collated and categorized by healthcare facility and service stream.

The study was approved by the Head of Health of the Western Cape Government (WCG), the WCP Health Research Committee, under the auspices of the National Health Research Database and the Health Research Ethics Committee of Stellenbosch University.

**Results**

**Provincial overview**

Approximately two-thirds of the WCP population live in the City of Cape Town Metropolitan District which constitutes just two percent of overall provincial land area. Metropolitan population density (1682 people/km²) exceeds rural (19 people/km²) by a factor of almost ninety (89:1).

**Imaging facilities**
There are sixty-eight (n = 68) provincial imaging facilities, all with plain radiography and fifty three (n = 53; 78%) with ultrasound services. The metropolitan and rural areas have 35 and 33 imaging facilities, respectively. As a result, rural resources by population are almost double the metropolitan (19 vs 11/10^6 people).

District Hospitals (n = 35, 51%) and Community Day Centres (n = 14, 21%) together account for almost three-quarters (n = 49, 72%) of all facilities, with Community Day Centres predominant (n = 9/35, 27%) in the metropole and District Hospitals (n = 26/34, 76%) in the rural areas. All Central (n = 3) and Community Health Centres (n = 10) are in the metropole, while the six Regional Hospitals are equally distributed between the two areas.

**Imaging equipment**

Of the 349 provincial equipment units, plain radiography constitute half (n = 174; 50%), ultrasound approximately a quarter (n = 89; 26%) and CT units less than five percent (n = 13; 4%).

There are 36 radiography and 18 ultrasound units per million people overall. However, the rural radiography (39.3 vs 33.6/10^6 people) and ultrasound (24.7 vs 14.5/10^6 people) resources exceed those in the metropole by 17 and 70 percent, respectively. Additionally, rural access to mammography is almost triple that in the metropole (14 vs 5 units/10^6 women > 40 years).

The provincial, metropolitan, and rural CT:ultrasound:radiography ratios are 1:7:13, 1:5:10 and 1:15:23, respectively.

**Imaging staff**

Almost eighty percent (n = 348; 79%) of the 443 provincial imaging personnel are in the metropole and more than three-quarters of all staff (n = 339; 77%) are radiographers.

Metropolitan personnel resources by population (n = 112 vs 53/10^6 people) and equipment unit (1.7 vs 0.7/10^6 people) are more than double the rural. Rural areas have more equipment units than personnel.

The provincial, metropolitan and rural radiologist:sonographer:radiographer ratios are 1:1:11, 1:0.8:10 and 1:2:16 respectively.

The potential average annual workload (excluding ultrasound) by radiologist at provincial, metropolitan and rural levels was 35820, 28910 and 63825 studies, respectively.

**Imaging service utilization**

More than 1.2 million studies were performed across the modalities, averaging 262 examinations/10^3 people and 1.3 investigations/patient. The CXR (n = 92/10^3 people) was the commonest single examination, while plain radiography accounted for almost three-quarters (n = 935607, 73%) of all
investigations. Radiography and ultrasound (n = 202639, 16%) together constituted almost ninety percent (n = 1138246, 89%) of all studies.

Overall population-based utilization of imaging services across the modalities was 30 percent higher in the metropole (279 vs 214 studies/10^3 people), with mammography (24 vs 5 studies/10^3 woman > 40 years; 517%) and CT (21 vs 6/10^3 people; 380%) recording the highest differentials and plain radiography utilization (203 vs 171/10^3 people; 19%) the lowest. However, overall patient-based utilization of services in the rural areas exceeded that in the metropole by 12 percent (1353 vs 1209 studies/10^3 patients) reflecting increased plain radiography and ultrasound usage.

The provincial, metropolitan and rural CT:ultrasound:radiography ratios were 1:3:12, 1:2:10, 1:6:31, respectively.

**Imaging equipment utilization:**

Provincial equipment units performed an average of 3660 studies annually. Average metropolitan equipment outputs by unit exceeded those in the rural area by more than fifty percent (4114 vs 2739/unit, 50%). The highest differences were in mammography (n = 6198 vs 458/unit) and fluoroscopy (n = 450 vs 140/unit).

**Discussion**

To our knowledge, this is the most detailed analysis of the usage of radiological services in a low- or middle-income country to date. It broadly reviews a provincial imaging platform, while allowing a better understanding of key differences between metropolitan and rural service provision and utilization. It therefore represents a seminal work in the field, that contributes significantly to discourses on equitable access to basic healthcare, universal health coverage and appropriate utilization of diagnostic imaging. It can serve as a benchmark resource and stimulate further work in this domain.

A key finding was that, in a population with access to the full range of modern imaging modalities, plain radiography and ultrasound examinations constituted 89% of all studies, with minimal (8%) differential between metropolitan and rural areas. This provides compelling support for the WHO contention (4,25,31–34) that approximately ninety percent of all imaging needs can be met by one plain radiography and one ultrasound machine for every 50 000 people, or 20 units each per million people. WCP plain radiography resources (36 units/10^6 people) are fifty percent above the WHO benchmark, while the availability of ultrasound equipment (18 units/10^6 people) is aligned with this guideline.

Provincial utilization of imaging services totalled 262 patient encounters/10^3 people, or approximately one engagement for every four people. However, the 30% difference between metropolitan (279/10^3 people) and rural (214/10^3 people) engagements underscores the challenge of equitable service provision to sparse rural populations, given that total rural equipment units/10^6 people exceeded metropolitan by a differential of 15%. Furthermore, despite the rural areas having 17%, 70% and 263%
greater equipment resources/10^6 people for radiography, ultrasound and mammography, respectively, corresponding utilization was 72%, 45% and 7% less than metropolitan. This highlights the truism that access to services is not simply a question of the equipment to population ratio.

By contrast, rural plain radiography and ultrasound examinations per patient were 23% and 10% higher than metropolitan, respectively. The increased investigation of rural patients may reflect relative clinical inexperience on the part of doctors working at smaller peripheral facilities, many being in their post-internship year (35). It may also reflect a mindset that patients who have travelled great distances at considerable expense merit the full ambit of available investigations.

This work provides novel insights into the differential equipment workload across the modalities and regions. CT (n = 5835) and plain radiography (n = 5377) achieved the highest average annual outputs per unit across the province, while fluoroscopy recorded the lowest (n = 347), being approximately 17-fold below that of CT. The limited use of fluoroscopy reflects declining global trends and suggests that provincial policy on fluoroscopic service provision merits review. Of note, less than 4 fluoroscopic investigations/10^3 people were performed across the province in the review period.

Rural equipment utilization by unit was less than metropolitan across all modalities. The smallest differential was in plain radiography, where the average rural unit (n = 4365) achieved 72% of metropolitan output (n = 6058), whilst the greatest difference was in mammography, with rural output (n = 458) a mere 7% of metropolitan (n = 6198). The optimal combination of equipment, personnel, and hours of operation for rural facilities remains a conundrum. WCP rural equipment resources currently exceed imaging personnel by 46% (n = 139 vs 95), likely contributing to decreased equipment utilization. A recent study of Zambian radiological equipment and personnel resources (22) found more than three Zambian diagnostic radiographers per equipment unit, nationally, and at least two radiographers per unit at provincial level, even in the most sparsely populated regions.

This study was limited by inability to accurately assess the ultrasound workload of the various categories of personnel, since ultrasound outputs were not stratified by type of healthcare worker. In the WCP, ultrasounds in the radiological domain are performed by registrars, sonographers, and dual-qualified radiographers, the latter performing both radiography and ultrasound. Dual-qualified radiographers and sonographers practice independently, while registrars generally report under consultant supervision. In the future, WCP ultrasound data would be enhanced by allocating outputs by category of healthcare worker. A further limitation is that many obstetric and gynaecological ultrasounds are not performed within the radiological department and are not included in this analysis.

Even allowing for uncertainty in ultrasound outputs by personnel category, this work provides important insights into the reporting workload generated by other modalities. Excluding ultrasounds, 722761 metropolitan and 319123 rural studies required reporting, including 630078 (87%) metropolitan and 305529 (96%) rural plain radiographs. This translates to a potential annual workload of 63 825 and 28 910 studies per radiologist in the rural and metropolitan areas, respectively.
Of note, most metropolitan radiologists have university affiliations, and thus both clinical and academic commitments, while rural consultants have exclusively clinical commitments. It is acknowledged that supervision of trainees impacts the clinical output of academic radiologists\(^{(36, 37)}\). There is thus wide acceptance that the clinical load of the academic radiologist should be capped\(^{(12, 37, 38)}\). The Royal Australian and New Zealand College of Radiologists (RANZCR) recommends a threshold of 12,000 examinations per year\(^{(12)}\). It has previously been shown that the increasing clinical workload of the WCP academic radiologist over the past decade has necessitated the prioritization of reporting of special investigations, such as fluoroscopy, CT, mammography, MRI and angiography, with resultant decreased capacity for plain radiograph reporting\(^{(39)}\). The average special investigation workload of the metropolitan radiologist in the review period was 3707 cases, representing a manageable annual workload when combined with selective plain radiograph reporting and educational commitments.

This is the first detailed appraisal of the potentially overwhelming workload of the rural radiologist. If all imaging studies performed in the rural areas were to be formally reported by a radiologist\(^{(n = 76131)}\) this would be more than 5-fold the average caseload\(^{(n = 14900)}\) documented for general radiology consultants working in the United States\(^{(40)}\) and more than nine times that of general radiologists\(^{(n = 8171)}\) in the United Kingdom (UK).\(^{(41)}\) It is clearly not a realistic expectation. In the rural areas of the WCP, the same pragmatic reporting policy applies, with mandatory special-investigation reporting, but selective plain radiograph reporting, making for a more realistic and sustainable consultant radiologist workload. The average special investigation workload of the individual rural radiologist in the review period was 2719 cases.

The challenge of meeting the ever-increasing demand for radiology reporting is not unique to LMICs.\(^{(42, 43)}\) A recent report showed that 97% of UK radiology departments were unable to meet all reporting requirements,\(^{(42)}\) that most delays involved plain radiograph reporting and that only 12% of trusts reported all radiological examinations. There were instances where trusts were not reporting the bulk of in-patient and emergency department plain radiographs.

Our study provides a compelling argument for upscaling undergraduate medical education programs in the interpretation of plain radiographs and the performance of basic ultrasound examinations. Equipped with such skills, medical graduates would be well-placed to address ninety percent of provincial reporting needs. Additionally, competence in basic interpretation of plain radiographs would address the current reporting void in this modality. Our study also shows that educational initiatives in CXR interpretation would be particularly beneficial, since almost half of all plain radiographic studies are CXR.

The increasing population dose from medical exposures to ionising radiation is a global concern.\(^{(26)}\) This study provides important utilization data for the WCP. This facilitates international comparisons, notwithstanding the WCP having a younger population and a higher prevalence of tuberculosis and HIV than the well-resourced countries for which comparative data are available.
WCP plain radiography utilization was compared with 2014 data from 35 European countries. (26, 44) Hungary (n = 581) and Romania (n = 143) have the highest and lowest plain radiographic examinations per 10^3 people, respectively. The WCP (n = 192) utilization is at the lower end of this range. WCP plain radiograph utilization is most closely aligned with Sweden (n = 201/10^3 people) and Denmark (n = 180/10^3 people)

To the best of our knowledge, the only comparable analysis of geographic variation in the utilization of radiographic services was conducted in Norway in 2002. (27) The study showed that Oslo (1532.7) and Finnmark (1.6) were the counties with the highest and lowest population densities, respectively. (45) Plain radiographic utilization in Oslo (921 studies/10^3 people) was double that in the more sparsely populated Finnmark (459 studies/10^3 people). By comparison, there was a 1:1.8 differential in plain radiographic utilization between metropolitan (203/10^3 people) and rural (171/10^3 people) areas of the WCP.

Our analysis also allowed comparison of WCP CT utilization with global data in 2014. (26, 44) The United States demonstrated the highest CT utilization (n = 271) and Costa Rica the lowest (n = 34) examinations per 10^3 population. CT utilization in the WCP (16/10^3 people) is less than half that of Costa Rica which is classified as an upper middle-income country by the World Bank. (46) WCP is below the range of reported international CT utilization figures.

**Conclusion**

This study has shown that in a population with access to the full range of modern imaging modalities, plain radiography and ultrasound constitute 89% of all radiological studies, with minimal variation between rural and metropolitan areas. Our findings therefore support the hitherto untested WHO contention that approximately ninety percent of a population’s diagnostic imaging needs can be met by these two basic imaging modalities.

The study also highlights WCP attempts to bridge the divide between rural and metropolitan access to imaging, through the provision of an increased number of imaging facilities and basic equipment units per million people in the rural compared to metropolitan areas. However, it also underscores the complexity of achieving equitable utilization of services between rural and metropolitan areas.

The achievement of equity in all aspects of healthcare must be seen as a process, involving incremental improvements and iterative analyses that define progress towards the ultimate goal. Studies such as this serve to define the baseline and inform future interventions to enhance equity going forward.

**Abbreviations**

**LMIC:** low- and middle-income countries

**SDG:** Sustainable Development Goals
Declarations

Ethics approval and consent to participate

The study was approved by the Head of Health of the Western Cape Government (WCG), the Western Cape Province Health Research Committee, under the auspices of the National Health Research Database and the Health Research Ethics Committee of Stellenbosch University (HREC Reference #: N17/10/098 and S20/08/201).

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

RDP conceived the project. BCVZ, MMB and AF contributed to the refining of the project concept. MMB and AF collection and collation of data. BCVZ conducted the data analysis with assistance from RDP. BCVZ drafted the initial manuscript. RDP provided editorial input and critical revision of the manuscript for intellectual content. MMB, AF, KB and MM provided critical review and contributed to the final manuscript. All authors read and approved the final manuscript.

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Table
Table 1
Results summary of the WCP radiological resources and utilization patterns with differentiation between metropolitan and rural services

|                         | Rural              | Metropolitan       | Western Cape Province (WCP) |
|-------------------------|--------------------|--------------------|-----------------------------|
| **Population (n)**      |                    |                    |                             |
| Total (%)               | 2366894 (37)       | 4114404 (63)       | 6481298                     |
| Persons dependent on public health care | 1782271           | 3098146            | 4880417                     |
| Women > 40 years dependant on public health care | 291138            | 509695             | 800833                      |
| Patients (per 10^3 people) | 282220 (158)      | 714093 (230)       | 996313 (204)                |
| **Geography**           |                    |                    |                             |
| Area (km2)              | 127018             | 2446               | 129464                      |
| Population density (people/km2) | 19               | 1682               | 50                          |
| Facilities with an imaging service per 10^6 people | 35 (20)          | 33 (11)            | 68 (14)                     |
| Central Hospital        | 0                  | 3                  | 3                           |
| Regional Hospital       | 3                  | 3                  | 6                           |
| District Hospital (% of facilities) | 26 (76)         | 8                  | 34 (51)                     |
| Day Hospital            | 0                  | 10                 | 10                          |
| Day Clinic (% of facilities) | 5                 | 9 (27)             | 14 (21)                     |
| Clinic                  | 1                  | 0                  | 1                           |
| **Personnel n (per 10^6 people)** |                |                    |                             |
| Radiologist             | 5 (3)              | 25 (8.1)           | 30 (6.1)                    |
| Registrar               | n/a                | 44 (14.2)          | 44 (9.0)                    |
| Radiographer            | 79 (44.3)          | 260 (83.9)         | 339 (69.5)                  |
| Sonographer             | 11 (6.2)           | 19 (6.1)           | 30 (6.1)                    |
| Total                   | 95 (53.3)          | 348 (112.3)        | 443 (90.8)                  |
| **Equipment n (per 10^6 people)** |            |                    |                             |
| Fixed x-ray             | 44 (24.7)          | 64 (20.7)          | 108 (22.1)                  |
| Service                        | Rural     | Metropolitan | Western Cape Province (WCP) |
|-------------------------------|-----------|--------------|-----------------------------|
| Mobile x-ray                  | 26 (14.6) | 40 (12.9)    | 66 (13.5)                   |
| **Total x-ray**               | **70 (39.3)** | **104 (33.6)** | **174 (35.7)** |
| Ultrasound                    | 44 (24.7) | 45 (14.5)    | 89 (18.2)                   |
| Fixed fluoroscopy             | 3 (1.7)   | 9 (2.9)      | 12 (2.5)                    |
| C-arm fluoroscopy             | 13 (7.3)  | 23 (7.4)     | 36 (7.4)                    |
| **Total fluoroscopy units**   | **16 (9.0)** | **32 (10.3)** | **48 (9.8)**                |
| Mammography units (per 10^6 women > 40 years) | 3 (14) | 2 (5.0) | 5 (8.0) |
| CT                            | 3 (1.7)   | 10 (3.2)     | 13 (2.7)                    |
| MRI                           | 3         | 3 (0.6)      |                            |
| Lodox                         | 3         | 3 (0.6)      |                            |
| Angiography                   | 9         | 9 (1.8)      |                            |
| Panoral                       | 3         | 2            | 5                           |
| **Total units**               | **139 (78)** | **210 (67.8)** | **349 (71.5)**              |
| **Studies (per 10^3 people)** | **380657 (213.6)** | **863866 (278.8)** | **1277244 (261.7)** |
| Chest x-ray (n)               | 132237    | 315539       | 447776                      |
| per 10^3 people               | 74.2      | 101.8        | 91.7                        |
| per 10^3 patients             | 469       | 442          | 449                         |
| General x-ray (n)             | 173292    | 314539       | 487831                      |
| per 10^3 people               | 97.8      | 101.5        | 100.0                       |
| per 10^3 patients             | 614       | 440          | 490                         |
| **Total x-ray (n)**           | **305529** | **630078**   | **935607**                  |
| per 10^3 people               | 171.4     | 203.4        | 191.7                       |
| per 10^3 patients             | 1083      | 882          | 939                         |
| per equipment unit            | 4365      | 6058         | 5377                        |
| Ultrasound (n)                | **61534** | **141105**   | **202639**                  |
|                      | Rural | Metropolitan | Western Cape Province (WCP) |
|----------------------|-------|--------------|----------------------------|
|                      | per 10³ people | per 10³ patients | per equipment unit |
| Fluoroscopy (n)      | 2247  | 14410        | 16657                      |
|                      | 1.3   | 4.7          | 3.4                        |
|                      | 8.0   | 20.2         | 16.7                       |
|                      | 140   | 450          | 347                        |
| Mammography (n)      | 1374  | 12396        | 13770                      |
|                      | 4.7   | 24.3         | 17.2                       |
|                      | 458   | 6198         | 2754                       |
| CT                   | 9973  | 65877        | 75850                      |
|                      | 5.6   | 21.3         | 15.5                       |
|                      | 35.3  | 92.3         | 76.1                       |
|                      | 3324  | 6588         | 5835                       |
| MR                   |       |              | 12504                      |
|                      | 2.6   |              |                            |
|                      | 12.6  |              |                            |
|                      | 4168  |              |                            |
| Lodox                |       |              | 4463                       |
|                      | 0.9   |              |                            |
|                      | 4.5   |              |                            |
|                      | 1488  |              |                            |
| Angiography          |       |              | 15754                      |
|                      | 3.2   |              |                            |
|                      | 15.8  |              |                            |
|                                      | Rural        | Metropolitan | Western Cape Province (WCP) |
|--------------------------------------|--------------|--------------|------------------------------|
| Per equipment unit                   |              |              | 1750                         |
| Normal hours (% of total Studies)    | 300468 (78.9)| 636264 (73.7)| 936732 (73.3)                |
| After hours (% of total Studies)     | 81372 (21.4) | 259140 (30)  | 340512 (26.7)                |
| **Total Studies**                    | 380657 (100) | 863866 (100) | 1277244 (100)                |
| x-ray and ultrasound (% of Studies)  | 367063 (96.4)| 771183 (89.3)| 1138246 (89.1)               |
| per 10³ people                       | 206          | 248.9        | 233.2                        |
| per 10³ patients                     | 1300.6       | 1079.9       | 1142.5                       |
| Workload (Excluding Ultrasound)      | 319123       | 722761       | 1074605                      |
| Workload per Radiologist             | 638245       | 28910        | 35820                        |
| Total Studies per equipment          | 2739         | 4114         | 3660                         |
| Ratio to Rural                       | 1            | 1.5          | 1.3                          |