**IMPAACT Network Data Request (DR)**

Submit the completed DR to the IMPAACT Operations Center for consideration by the Network using this email address: [impaact.capsubmissions@fstrf.org](mailto:impaact.capsubmissions@fstrf.org). Upon receipt, the IMPAACT Operations Center will contact you to provide information concerning the next steps.

**Request Submitted by:** Professor Matthew Chersich [mchersich@wrhi.ac.za](mailto:mchersich@wrhi.ac.za)

**Date submitted:**

**Scientific Area(s):** (please check all that apply)

|  |  |  |  |
| --- | --- | --- | --- |
| Complications/Coinfections | ( X ) | Tuberculosis | ( ) |
| HIV Treatment | ( X ) | ART-Free Remissions | ( ) |

**Title:** Developing data science solutions to mitigate the health impacts of climate change in Africa

**Proposing Investigators:** Include name(s), institution(s), phone number(s), email(s).

Check here to attest that all listed investigators are supportive of this proposal.

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**Relevant IMPAACT Studies:** List all IMPAACT/PACTG studies from which data are being requested.

1. Evaluating Strategies to Reduce Mother-to-Child Transmission of HIV Infection in Resource-Limited Countries (PROMISE: 1077 BF)\_Johannesburg (NCT01061151)
2. PROMISE EBF: Promoting Infant Health and Nutrition in Sub-Saharan Africa: Safety and Efficacy of Exclusive Breastfeeding Promotion in the Era of HIV\_Johannesburg (NCT00397150)

**Rationale:** The rationale for the proposed research project is to advance the understanding of the impacts of heat exposure on health outcomes in large African cities, with a focus on vulnerable populations.

Global temperatures have already risen about 1.2°C, and the world is on track for an increase of 1.5°C within the next decades. Many large and rapidly growing African cities face significant health risks from observed past and projected future temperature increases, due to the phenomenon of 'Urban Heat Islands' where concrete or asphalt surfaces, for example, absorb and retain heat, and cooling areas, such as parks are limited. Therefore, data and understanding on heat-health outcomes, exposure, vulnerability, and potential solutions in African urban contexts are a major public health priority.

Moreover, the proposed research project aims to develop a personalized Heat-Health Early Warning System that can capture unique geospatial and individualized heat risk patterns and provide timely warnings to city planners, public health officials, and community leaders. This system will assist in preparing for heat waves or brief periods of extreme heat and ultimately reduce the negative health impacts of heat exposure in African urban contexts.

Overall, the proposed research project aims to address a major public health issue facing people living in large and rapidly growing African cities, and to provide valuable insights that can inform resource prioritization and allocation for public health interventions.

**Primary Objectives:**

The primary objective are:

1. To create an index of African cities' intra-urban socio-economic and environmental vulnerability.
2. To construct a spatially and demographically explicit heat-health outcome model that allows researchers to predict the likelihood of adverse health outcomes days or weeks prior to extreme weather events.
3. To develop an Early Warning System based on the heat-health outcome forecast model that can alert cities and communities about potential health risks associated with extreme weather events, particularly those related to high temperatures.
4. To evaluate the efficacy and accuracy of different machine learning techniques, such as recurrent neural networks (RNNs), long short-term memories (LSTMs), and gated recurrent units (GRUs), in predicting the health effects of extreme heat events.
5. To develop a robust and accurate predictive model that can be used to forecast the health effects of extreme heat events, which can be useful in developing effective strategies to mitigate the effects of climate change on urban areas in Africa

**Secondary Objectives: N/A**

**Relevant IMPAACT studies:** List all IMPAACT studies that are pertinent to the research questions and from which data and/or specimens will be used.

1. Evaluating Strategies to Reduce Mother-to-Child Transmission of HIV Infection in Resource-Limited Countries (PROMISE: 1077 BF)\_Johannesburg (NCT01061151)
2. PROMISE EBF: Promoting Infant Health and Nutrition in Sub-Saharan Africa: Safety and Efficacy of Exclusive Breastfeeding Promotion in the Era of HIV\_Johannesburg (NCT00397150)

Prof Lee Fairlie, part of our project was also an investigator in the PROMISE study at Shandukani, Wits RHI in Johannesburg, South Africa and will be able to provide useful study insights.

**Data Management and Data Analysis:** Identify the responsible parties for both data management and analysis (e.g., IMPAACT SDMC, drug company, CRS/CTU), and identify specific variables and associated CRF(s) required for the analysis. If an SDAC statistician has already worked on this concept sheet prior to submission, e.g., by providing sample size calculations (which is NOT mandatory), please provide the statistician's name.

The HE2AT Center has a dedicated, transdisciplinary, data management and analysis core (DMAC) led by Dr Chris Jack from the Climate Science Analysis Group at the University of Cape Town. The team comprises members from the HE2AT Center partner institutions with data science, data management, and analysis skill and expertise present.

|  |  |  |  |
| --- | --- | --- | --- |
| **Role and responsibilities** | **People** | **Institution** | **Contact** |
| **DMAC PIs**  Responsible for ongoing (quarterly) assessment of data management and changes to the data management plan (annual) | Christopher Jack  Sibusisiwe Makhanya | UCT  IBM | [cjack@csag.uct.ac.za](mailto:cjack@csag.uct.ac.za)  [sibusisiwe.makhanya@ibm.com](mailto:sibusisiwe.makhanya@ibm.com) |
| **Health data acquisition**  Identification of relevant health datasets, coordination and development of the DSA | Matthew Chersich  Craig Parker  Relebohile Montana | WITS RHI  WITS RHI  WITS RHI | [MChersich@wrhi.ac.za](mailto:MChersich@wrhi.ac.za)  [cparker@wrhi.ac.za](mailto:cparker@wrhi.ac.za)  rmontana@wrhi.ac.za |
| **Data processing and harmonization (including de- identification)**  De-identification, quality control, remapping, harmonization and integration of all datasets  Note: These are the only individuals with access to encryption keys for original sensitive data | Lisa van Aardenne  Pierre Kloppers  Piotr Wolski  Nelson Bore  Toby Kurien | UCT  UCT  UCT  IBM  IBM | [lisa@csag.uct.ac.za](mailto:lisa@csag.uct.ac.za)  [pierre@csag.uct.ac.za](mailto:pierre@csag.uct.ac.za)  [wolski@csag.uct.ac.za](mailto:wolski@csag.uct.ac.za)  [nelson.bore@ibm.com](mailto:nelson.bore@ibm.com)  [toby.kurien@za.ibm.com](mailto:toby.kurien@za.ibm.com) |
| **Managing access to UCT data analysis platform** | Rodger Duffett | UCT | [rodger@csag.uct.ac.za](mailto:rodger@csag.uct.ac.za) |
| **Managing access to IBM PAIRS platform** | Toby Kurien | IBM | [toby.kurien@ibm.com](mailto:toby.kurien@ibm.com) |

**Health data acquisition**

We have performed a systematic review that has identifiedclinical trials datasets generated by clinical trials undertaken in the case study cities (initially Johannesburg and Abidjan). Trials datasets will be identified based on the scale of the trial as well as the availability of geospatial variables (e.g. clinic locations or other geospatial information) in order to allow spatial mapping of health outcomes and the intersection with socio-economic spatial mapping and climate variable spatial mapping.

The below attached, Annexure A lists all the variables of interest that we would like to acquire for analysis.

Environmental data acquisition:

Climate data include both observational-based datasets (weather station observations, and satellite proxy observations) and processed/gridded observations.  Gridded climate data produced from atmospheric re-analysis and climate simulations will form historical gridded climate observations and forecasts. Climate-related data will in almost all cases involve accessing open data repositories such as Copernicus Climate Data Store (CDS) or Earth System Grid Federation data systems.  Climate related data will either be stored on IBM Physical Analytics Integrated Data and Repository Services (PAIRS) data storage and/or Climate Science Analysis Group/University of Cape Town (CSAG/UCT) data storage systems. It is anticipated that all climate datasets that will be used are available through open data policies with no restrictions on non-commercial research use.

Remotely-sensed data from satellite sensors, mainly optical imagery (e.g., satellite images of urban centers) are a source of valuable information about physical attributes such as land surface temperature, soil moisture estimates, vegetation condition, land use and cover and air quality, etc.  Raw and processed geospatial datasets from satellites will in almost all cases involve accessing open data repositories such as Copernicus Climate Data Store (CDS) and sentinel data systems. There are large volumes of these data downloaded from these open data repositories that have already been pre-processed that are currently stored on the IBM PAIRS and the CSAG/UCT data platforms.

Air pollution data will be required to consider the joint exposure of participants to both air pollution and heat. The challenge to air pollution analyses in Africa is gaps in the coverage of the ground-based air quality monitoring network of stations. Therefore, proxy satellite-derived air quality data such as Aerosol Optical Depth (AOD) from for example, Sentinel 3 or the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the Earth Observing System Terra and Aqua in combination with land cover and use data can be another option to consider for the provision of estimates of air quality at each of the study locations. Indoor air pollution is a major health risk in many parts of Africa. Data on this variable are seldom available. If data has been collected in some studies on cooking type, for example, that may be a useful proxy for indoor pollution. Analyses may use only certain variables, depending on data availability.

Once we obtain our data, the individual datasets will be harmonised through the recoding of raw individual participant data into a common set of variables. We will combine environmental and health data obtained. A one and/or two-stage analysis method will be adopted whereby, in the first-stage, each study is analysed individually. Then, in the second stage, the data from the individual studies are aggregated to provide a pooled estimate of effect. If heterogeneity between studies is high, then aggregation across studies may not be done, or only be done only in particular groups of studies that share common characteristics, or in particular sub-groups in each study. Various traditional models such as time-series analysis, time-to event analysis and generalised additive models as well as novel machine learning approaches will be used to quantify associations between exposure to high ambient temperatures, and adverse maternal and child outcomes.

**Ethical considerations**:

We aim to minimize risk to the privacy of participants. We will not be collecting names of participants and no identifiable data will be published. In addition, the data will be safeguarded in a password protected server with limited access to named individuals. We will also use principles of data minimisation, to ensure that only essential data that is required for the study objectives are stored. Lastly, wherever possible, we will anonymise data, for example, For example, for some research analysis, street address level personal information is not required and will be replaced by larger area references such as South African census areas.

**Timeline for Completion:**

The HE2AT Center project will be completed in June 2026. I have attached a Gantt chart for project milestones below, that details expected timelines for data acquisition and manuscript writing. We anticipate data collection to continue far into the project timelines. Manuscripts will be drafted, and peer-reviewed papers published throughout the project timelines – we will update analyses as new data becomes available.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Sept**  **2021-June 2022** | | | | | **July 2022-**  **June 2023** | | | | **July 2023-**  **June 2024** | | | | **July 2024-**  **June 2025** | | | | **July 2025-**  **June 2026** | | | | **Co\*** |
| **Milestones Study quarters** | **1** | **2** | **3** | **4** | **1** | | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1-4** |
| Research Project 2 | | | | | | | | | | | | | | | | | | | | | | |
| Initial and continuing IRB and ethics compliance (M6) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Training of HE²AT Center on Research Project 2 methods (M6) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Protocol paper published (M12) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data analysis plan written (M6) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data harmonization across DSI-Africa platform and other grantees(M12) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Biomedical data recoded and merged into one database (M8) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Database prepared for vulnerability-heat-health analysis (M12) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Publications submitted on primary and secondary study outcomes |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Engagement with national government for EWS development |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Stakeholder engagements (community and health departments) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Publications submitted on Methodological aspects (M38) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Publication on vulnerability-heat-health data |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Review of District-level surveillance systems performance (M38) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PhD enrolment (M7) until award (M54) of one student |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dissemination meetings and conferences |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Final report submitted (M58) |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**References:**

1. Chersich MF, Pham MD, Areal A, Haghighi MM, Manyuchi A, Swift CP, Wernecke B, Robinson M, Hetem R, Boeckmann M, Hajat S, Climate C, Heat-Health Study G. **Associations between high temperatures in pregnancy and risk of preterm birth, low birth weight, and stillbirths: systematic review and meta-analysis**. *BMJ* 2020; 371:m3811.https://www.ncbi.nlm.nih.gov/pubmed/33148618 10.1136/bmj.m3811
2. Analitis, A., et al., **Synergistic Effects of Ambient Temperature and Air Pollution on Health in Europe: Results from the PHASE Project.** Int J Environ Res Public Health, 2018. 15(9).
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# Annex A: List of variables for Research Project 2

1. **Cross-sectional time invariant variables**

| Variable category | Variable name (examples) | Definition |
| --- | --- | --- |
| Demographics and socio-economic status | Location of study follow-up | The place where the follow-up assessment or examination was conducted. |
| Location of participant | The location where the participant resides or lives. |
| Household address | The specific address of the household where the participant resides or lives. |
| Housing type | The type of housing or accommodation in which the participant lives, such as apartment, house, or informal housing. |
| No. of people in household | The number of people who reside or live in the same household as the participant. |
| Air conditioning access | Whether the participant has access to air conditioning in their living quarters or not. |
| Socio-economic status indices | Measures of the economic and social standing of the participant or their household. |
| Personal income | The amount of money the participant earns from their personal work or business |
| Household income | The total amount of money earned by all members of the household, including the participant. |
| Race | The ethnic or racial identity of the participant. |
| Substance use | The use of drugs or alcohol by the participant. |
| Smoking or alcohol use | The frequency and amount of tobacco or alcohol use by the participant |
| Employment status | Whether the participant is currently employed or not. |
| Education (highest level achieved) | The highest level of education completed by the participant. |
| Marital status | The current marital status of the participant. |
| Religion | The religious affiliation of the participant. |
| Loss to follow-up | Whether the participant was lost to follow-up during the study period or not. |
| Date of interview/examination/special investigations | The date when the interview, examination, or special investigation was conducted. |
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1. **Repeated measure variables**

| Variable category | Variable name (examples) | Definition |
| --- | --- | --- |
| Anthropometry | Height | The height of the participant, usually measured in centimeters or feet and inches. |
| Weight | The weight of the participant, usually measured in kilograms or pounds. |
| Other measures of obesity | Other measures of obesity, such as body mass index (BMI), waist circumference, or body fat percentage |
| Previous medical history | Ischemic heart disease | A history of heart disease caused by reduced blood flow to the heart muscle. |
| Stroke | A history of stroke or cerebrovascular accident. |
| Heart failure | A history of heart failure or a weakened heart. |
| Chronic lung or renal disease | A history of chronic lung or renal disease, such as chronic obstructive pulmonary disease (COPD) or chronic kidney disease (CKD). |
| Chronic medication | A list of chronic medications that the participant is taking for their medical conditions. |
| Physical examination | Systolic blood pressure | The pressure in the arteries when the heart beats and pushes blood out, usually measured in millimeters of mercury (mmHg). |
| Diastolic blood pressure | The pressure in the arteries when the heart is resting between beats, usually measured in millimeters of mercury (mmHg). |
| Heart rate | Heart rate: The number of times the heart beats per minute, usually measured by feeling the pulse or using an electrocardiogram (ECG). |
| Body temperature | The temperature of the body, usually measured in degrees Celsius or Fahrenheit using a thermometer. |
| Respiratory rate | The number of breaths a person takes per minute, usually measured by counting breaths. |
| Signs of dehydration | Physical signs of dehydration, such as dry mouth, thirst, decreased urine output, or sunken eyes. |
| Systems(cardiovascular, respiratory, abdominal, skin, neurological, general) | (cardiovascular, respiratory, abdominal, skin, neurological, general): Assessment of different systems in the body, including the cardiovascular system, respiratory system, abdominal organs, skin, nervous system, and general appearance. |
| Adverse events | Metabolism and nutrition disorders | Disorders related to the body's metabolism or nutrition, such as diabetes, obesity, or malnutrition. |
| Nervous system disorders | Disorders of the nervous system, such as Parkinson's disease, multiple sclerosis, or epilepsy. |
| Reproductive system and breast disorders | Disorders of the reproductive system or breast, such as infertility, breast cancer, or uterine fibroids. |
| Investigations | Results of medical tests or investigations, such as blood tests, imaging studies, or biopsies |
| Gastrointestinal disorders | Disorders of the gastrointestinal tract, such as gastroesophageal reflux disease (GERD), inflammatory bowel disease (IBD), or peptic ulcers. |
| Infections and infestations | Infections or infestations caused by bacteria, viruses, fungi, or parasites, such as influenza, HIV/AIDS, or malaria. |
| Immune system disorders | Disorders of the immune system, such as allergies, autoimmune diseases, or immunodeficiencies. |
| Renal and urinary disorders | Disorders of the kidneys or urinary tract, such as kidney failure, urinary tract infections (UTIs), or kidney stones |
| Blood and lymphatic system disorders | Disorders of the blood or lymphatic system, such as anemia, leukemia, or lymphoma. |
| Musculoskeletal and connective tissue disorders | Disorders of the muscles, bones, joints, or connective tissues, such as arthritis, osteoporosis, or tendonitis. |
| Injury, poisoning and procedural complications | Adverse events related to injuries, poisonings, or medical procedures, such as surgical complications, medication errors, or accidental injuries. |
| Skin and subcutaneous tissue disorders | Disorders of the skin or subcutaneous tissue, such as acne, eczema, or psoriasis. |
| Eye disorders | Disorders of the eye, such as glaucoma, cataracts, or macular degeneration. |
| Respiratory, thoracic and mediastinal disorders | Disorders of the respiratory system, such as asthma, chronic obstructive pulmonary disease (COPD), or pneumonia. |
| Psychiatric disorders | Mental or behavioral disorders, such as depression, anxiety, or schizophrenia. |
| Vascular disorders | Disorders of the blood vessels, such as hypertension, peripheral artery disease (PAD), or deep vein thrombosis (DVT). |
| Ear and labyrinth disorders | Disorders of the ear or labyrinth, such as hearing loss, tinnitus, or vertigo. |
| Neoplasms benign, malignant and unspecified | Neoplasms benign, malignant and unspecified: Tumors or abnormal growths, either cancerous or non-cancerous. |
| Pregnancy, puerperium and perinatal conditions | Refers to medical conditions related to pregnancy, childbirth, and the postpartum period, as well as conditions affecting the newborn infant. This category includes a wide range of conditions, such as gestational diabetes, preeclampsia, preterm labor, fetal distress, birth defects, and neonatal jaundice. These conditions are of particular interest to researchers and healthcare providers who are studying maternal and child health and working to improve outcomes for mothers and infants. |
| General disorders and administration site conditions | Adverse events related to general disorders, such as fever, fatigue, pain, or administration site reactions, such as injection site pain, swelling, or redness. |
| Hepatobiliary disorders | Adverse events related to the liver, gallbladder, or bile ducts, such as hepatitis, liver failure, or cholecystitis |
| Congenital, familial and genetic disorders | Adverse events related to inherited or genetic conditions, such as Down syndrome, cystic fibrosis, or sickle cell anemia. |
| Social circumstances | Adverse events related to social or environmental factors, such as poverty, homelessness, or lack of social support. |
| Endocrine disorders | Adverse events related to the endocrine system, such as diabetes, thyroid disease, or adrenal insufficiency |
| Cardiac disorders | Adverse events related to the heart, such as arrhythmias, myocardial infarction, or angina. |
| Surgical and medical procedures | Adverse events related to surgical or medical procedures, such as infections, bleeding, or complications from anesthesia |
| Haematology | Basophils | Basophils are a type of white blood cell that works closely with your immune system to defend your body from allergens, pathogens and parasites. Basophils release enzymes to improve blood flow and prevent blood clots. |
| CD4 cell % | In addition to using a test to count the number of CD4 cells, doctors sometimes measure the proportion of all white blood cells that are CD4 cells. This is called a CD4 cell percentage. |
| CD4 cell count | CD4 cells, also known as T cells, are white blood cells that fight infection and play an important role in your immune system. A CD4 count is used to check the health of the immune system in people infected with HIV (human immunodeficiency virus). HIV attacks and destroys CD4 cells. |
| Monocytes | Monocytes are a type of white blood cell (leukocytes) that reside in your blood and tissues to find and destroy germs (viruses, bacteria, fungi and protozoa) and eliminate infected cells. Monocytes call on other white blood cells to help treat injury and prevent infection. |
| Neutrophils | Neutrophils help your immune system fight infections and heal injuries. Neutrophils are the most common type of white blood cell in your body. An absolute neutrophil count identifies whether your body has enough neutrophils or if your count is above or below a healthy range. |
| Platelet count | A platelet count is a test that measures the number of platelets in your blood. Platelets are cells that help your blood clot. Too few platelets can be a sign of cancer, infections or other health problems. Too many platelets put you at risk for blood clots or stroke. There are tens of thousands of platelets in a single drop of blood. |
| RBC(Red Blood Count) | A red blood cell (RBC) count measures the number of red blood cells, also known as erythrocytes, in your blood. Red blood cells carry oxygen from your lungs to every cell in your body. Your cells need oxygen to grow, reproduce, and stay healthy. An RBC count that is higher or lower than normal is often the first sign of an illness. So the test may allow you to get treatment even before you have symptoms. |
| RDW (Red Cell Distribution Width) | A red cell distribution width (RDW) test measures the differences in the volume and size of your red blood cells (erythrocytes). Red blood cells carry oxygen from your lungs to every cell in your body. Your cells need oxygen to grow, make new cells, and stay healthy. |
| WBC (White Blood Count) | A white blood count measures the number of white cells in your blood. White blood cells are part of the immune system. They help your body fight off infections and other diseases. When you get sick, your body makes more white blood cells to fight the bacteria, viruses, or other foreign substances causing your illness. |
| Haematocrit | measures the proportion of red blood cells in your blood. Red blood cells carry oxygen throughout your body. Having too few or too many red blood cells can be a sign of certain diseases. The hematocrit test, also known as a packed-cell volume (PCV) test, is a simple blood test. |
| Liver function | Alanine aminotransferase (ALT) | An alanine transaminase (ALT) blood test measures the amount of ALT in your blood. ALT levels in your blood can increase when your liver is damaged, so healthcare providers often use an ALT blood test to help assess the health of your liver. |
| Aspartate aminotransferase (AST) tes | The aspartate aminotransferase (AST) test is a blood test that checks for liver damage. Your doctor might order this test to find out if you have liver disease and to monitor your treatment. |
| Total bilirubin and conjugated bilirubin | Unconjugated: This is the bilirubin once it reaches the liver and undergoes a chemical change. It moves to the intestines before being removed through your stool. Conjugated This is the bilirubin once it reaches the liver and undergoes a chemical change. It moves to the intestines before being removed through your stool. |
| Gamma-glutamyl Transferase (GGT) Test | A gamma-glutamyl transferase (GGT) test measures the amount of GGT in the blood. GGT is an enzyme found throughout the body, but it is mostly found in the liver. When the liver is damaged, GGT may leak into the bloodstream. High levels of GGT in the blood may be a sign of liver disease or damage to the bile ducts. Bile ducts are tubes that carry bile in and out of the liver. Bile is a fluid made by the liver. It is important for digestion. |
| Renal function | GFR or Creatinine clearance | A measure of the kidney function, either by estimating the glomerular filtration rate (GFR) or by measuring the creatinine clearance. GFR is a calculated value based on blood creatinine levels, age, sex, and race, while creatinine clearance is a measure of how much blood is cleared of creatinine by the kidneys in a given period of time. Both measures are used to assess the severity of kidney disease or to monitor the effect of treatments on kidney function. |
| Urea | A waste product of protein metabolism that is excreted by the kidneys. Urea levels in the blood can be used to evaluate kidney function, as well as liver function or dehydration. |
| Creatinine | Creatinine is a chemical compound left over from energy-producing processes in your muscles. Healthy kidneys filter creatinine out of the blood. Creatinine exits your body as a waste product in urine. |
| Urea to creatinine ratio | A waste product of muscle metabolism that is excreted by the kidneys. Creatinine levels in the blood can be used to evaluate kidney function, as well as muscle mass or dietary protein intake. |
| Lipids | HDL (high-density lipoprotein) | A type of cholesterol that is considered "good" because it helps remove excess cholesterol from the bloodstream and carry it back to the liver for processing. High levels of HDL are associated with a lower risk of heart disease, while low levels are associated with a higher risk |
| LDL (low-density lipoprotein) | A type of cholesterol that is considered "bad" because it can build up in the walls of arteries and form plaques that narrow or block blood flow. High levels of LDL are associated with a higher risk of heart disease, while low levels are associated with a lower risk |
| Total cholesterol | The total amount of cholesterol in the blood, including both HDL and LDL. High levels of total cholesterol are associated with a higher risk of heart disease, while low levels are associated with a lower risk. Total cholesterol levels are often used in combination with HDL and LDL levels to evaluate cardiovascular risk and guide treatment decisions |