National Health and Nutrition Examination Survey

2015-2016 Data Documentation, Codebook, and Frequencies

Standard Biochemistry Profile (BIOPRO_I)

Data File: BIOPRO_I.xpt

First Published: September 2017

Last Revised: NA

Component Description

These series of measurements are used in the diagnosis and treatment of certain liver, heart, and kidney diseases; acid-base imbalance in the respiratory and metabolic systems; other diseases involving lipid metabolism; various endocrine disorders; as well as other metabolic or nutritional disorders.

Alanine Aminotransferase (ALT)

Alanine aminotransferase measurements are used in the diagnosis and treatment of certain liver diseases (e.g., viral hepatitis and cirrhosis) and heart diseases. Elevated levels of the transaminases can indicate myocardial infarction, hepatic disease, muscular dystrophy, or organ damage. Serum elevations of ALT activity are rarely observed, except in parenchymal liver disease, since ALT is a more liver-specific enzyme than aspartate aminotransferase (AST).

Albumin

Albumin measurements are used in the diagnosis and treatment of diseases involving the liver and/or kidneys, and are frequently used to assess nutritional status because plasma levels of albumin are dependent on protein intake.

Alkaline Phosphatase (ALP)

Alkaline phosphatase measurements are used in the diagnosis and treatment of liver, bone, and parathyroid disease.

Aspartate Aminotransferase (AST)

AST measurements are used in the diagnosis and treatment of certain types of liver and heart disease. Elevated levels of the transaminases can signal myocardial infarction, hepatic disease, muscular dystrophy, or organ damage.

Bicarbonate (HCO3)

Together with pH determination, bicarbonate measurements are used in the diagnosis and treatment of numerous potentially serious disorders associated with acid-base imbalance in the respiratory and metabolic systems.

Blood Urea Nitrogen (BUN)

BUN measurements are used in the diagnosis of certain renal and metabolic diseases. The determination of serum urea nitrogen is the most widely used test for the evaluation of kidney function. The test is frequently requested in conjunction with the serum creatinine test for the differential diagnosis of prerenal, renal, and post renal uremia. High BUN levels are associated with impaired renal function, increased protein catabolism, nephritis, intestinal obstruction, urinary obstruction, metallic poisoning, cardiac failure, peritonitis, dehydration, malignancy, pneumonia, surgical shock, Addison's disease, and uremia. Low BUN levels are associated with amyloidosis, acute liver disease, pregnancy, and nephrosis. Normal variations are observed according to a person's age and sex, the time of day, and their diet – particularly in their protein intake.

Cholesterol

An elevated cholesterol level is associated with diabetes, nephrosis, hypothyroidism, biliary obstruction, and those rare cases of idiopathic hypercholesterolemia and hyperlipidemia; low levels are associated with hyperthyroidism, hepatitis, and sometimes severe anemia or infection.

Creatinine

Creatinine measurements are useful in the diagnosis and treatment of renal diseases.

Creatine Phosphokinase (CPK)

Measurements of creatine kinase are used in the diagnosis and treatment of myocardial infarction, skeletal muscle diseases, and diseases of the central nervous system.

Gammaglutamyl Transaminase (GGT)

GGT measurements are principally used to diagnose and monitor hepatobiliary disease. It is currently the most sensitive enzymatic indicator of liver disease, with normal values rarely found in the presence of hepatic disease. It is also used as a sensitive screening test for occult alcoholism. Elevated levels are found in patients who chronically take drugs such as phenobarbital and phenytoin.

Globulin

Globulins are a diverse group of proteins that transport various substances in the blood. They are also involved in various defense mechanisms within the body. Measurements of globulin are calculated **(Total protein - Albumin)**, and are used to determine the serum globulin concentration.

Glucose

Glucose measurements are used in the diagnosis and treatment of pancreatic islet cell carcinoma and of carbohydrate metabolism disorders, including diabetes mellitus, neonatal hypoglycemia, and idiopathic hypoglycemia.

Iron

Iron (non-heme) measurements are used in the diagnosis and treatment of diseases, such as iron deficiency anemia, chronic renal disease, and hemochromatosis (a disease associated with widespread deposit in the tissues of two iron-containing pigments, hemosiderin and hemofuscin, and characterized by pigmentation of the skin).

Lactate Dehydrogenase (LDH)

LDH measurements are used in the diagnosis and treatment of liver diseases such as acute viral hepatitis, cirrhosis, and metastatic carcinoma of the liver; cardiac diseases, such as myocardial infarction; and tumors of the lungs or kidneys.

Osmolality

Serum osmolality is a measure of the number of dissolved particles in a solution. Osmolality is a calculated value on the chemistry analyzer: [(1.86*Na) + (GLUC/18) + (BUN/2.8) + 9].

Phosphorus

There is a reciprocal relationship between serum calcium and inorganic phosphorus. Any increase in the level of inorganic phosphorus causes a decrease in the calcium level by a mechanism not clearly understood. Hyperphosphatemia is associated with vitamin D hypervitaminosis, hypoparathyroidism, and renal failure. Hypophosphatemia is associated with rickets, hyperparathyroidism, and Fanconi syndrome.

Measurements of inorganic phosphorus are used in the diagnosis and treatment of various disorders, including parathyroid gland, kidney diseases, and vitamin D imbalance.

Potassium, Chloride, and Sodium

Hypokalemia (low serum potassium level) is associated with body potassium

deficiency, excessive potassium loss caused by prolonged diarrhea or prolonged periods of vomiting and increased secretion of mineralocorticosteroids. Hyperkalemia (increased serum potassium level) is associated with oliguria, anuria, and urinary obstruction.

Low serum chloride values are associated with salt-losing nephritis; Addisonian crisis, prolonged vomiting, and metabolic acidosis caused by excessive production or diminished excretion of acids. High serum chloride values are associated with dehydration and conditions causing decreased renal blood flow, such as congestive heart failure.

Sodium measurements are used in the diagnosis and treatment of diseases involving electrolyte imbalance.

Total Bilirubin

Elevated levels are associated with hemolytic jaundice, paroxysmal hemoglobinuria, pernicious anemia, polycythemia, icterus neonatorum, internal hemorrhage, acute hemolytic anemia, malaria, and septicemia.

Low bilirubin levels are associated with aplastic anemia, and certain types of secondary anemia resulting from toxic therapy for carcinoma and chronic nephritis.

Total Calcium

Calcium measurements are used in the diagnosis and treatment of parathyroid disease, bone diseases, chronic renal disease and tetany. Urinary calcium measurement is used in the differential diagnosis of hypercalciuria**.**

Total Protein

Total protein measurements are used in the diagnosis and treatment of a variety of diseases involving the liver, kidney, or bone marrow, as well as other metabolic or nutritional disorders.

Triglycerides

Triglyceride measurements are used in the diagnosis of diabetes mellitus, nephrosis, liver obstruction, and other diseases involving lipid metabolism and various endocrine disorders and in the treatment of patients with these diseases.

Uric Acid

Uric acid measurements are used in the diagnosis and treatment of numerous renal and metabolic disorders, including renal failure, gout, leukemia, psoriasis, starvation, or other wasting conditions and in the treatment of

patients receiving cytotoxic drugs.

Eligible Sample

Examined participants aged 12 years and older were eligible.

Description of Laboratory Methodology

NOTE: Glucose, cholesterol, and triglycerides were analyzed as part of this profile. However, the results do not replace the reference method data from NHANES 2015-2016 samples analyzed at other institutions.

Alanine Aminotransferase (ALT)

The DxC800 uses a kinetic rate method to measure ALT activity in serum or plasma. In the reaction, ALT catalyzes the reversible transamination of L-alanine and a-ketoglutarate to pyruvate and L-glutamate. The pyruvate is then reduced to lactate in the presence of lactate dehydrogenase (LDH) with the concurrent oxidation of NADH to NAD. The system monitors the rate of change in absorbance at 340 nm over a fixed-time interval. The rate of change in absorbance is directly proportional to the ALT activity in the sample.

Albumin

The DcX800 method is used to measure the albumin concentration as a bichromatic digital endpoint method. In the reaction, the albumin combines with Bromcresol Purple (BCP) reagent to form a complex. The system monitors the change in absorbance at 600 nm. The change in absorbance is directly proportional to the concentration of albumin in the sample.

Aspartate Aminotransferase (AST)

The DxC800 uses an enzymatic rate method to measure the AST activity in serum or plasma. In the reaction, the AST catalyzes the reversible transamination of L-aspartate and a-ketoglutarate to oxaloacetate and L-glutamate. The oxaloacetate is then reduced to malate in the presence of malate dehydrogenase with the concurrent oxidation of NADH to NAD. The system monitors the rate of change in absorbance at 340 nm over a fixed-time interval. The rate of change in absorbance is directly proportional to the AST activity in the sample.

Alkaline Phosphatase (ALP)

The DxC800 system uses a kinetic rate method using a 2-Amino-2-Methyl-1-Propanol (AMP) buffer to measure ALP activity in serum or plasma. In the

reaction, the ALP catalyzes the hydrolysis of the colorless organic phosphate ester substrate, p-Nitrophenylphosphate, to the yellow colored product p-Nitrophenol and phosphate. This reaction occurs at an alkaline pH of 10.3. The system monitors the rate of change in absorbance at 410 nm over a fixed-time interval. This rate of change in absorbance is directly proportional to the ALP activity in the serum.

Bicarbonate (HCO_3)

The DxC800 system uses indirect (or diluted) I.S.E. (ion selective electrode) methodology to measure the total CO_2 level in serum, plasma or urine. The system measures the rate of pH change as CO_2 ions diffuse across a membrane. The electrode used for CO_2 determination is actually a pH electrode with the tip covered by a silicone rubber membrane and lowers the pH of a bicarbonate solution between the tip of the membrane and the tip of the pH electrode. The rate of pH change is directly proportional to the carbon dioxide (CO_2) in the sample.

Blood Urea Nitrogen (BUN)

The DxC800 modular chemistry (BUN) is used to quantitatively determine the concentration of blood urea nitrogen in serum or plasma by means of the enzymatic conductivity rate method. A precise volume of sample is injected into the urease reagent in a reaction cup containing an electrode that responds to changes in solution conductivity. Electronic circuits determine the rate of increase in conductivity, which is directly proportional to the concentration of urea in the sample.

Calcium

The DxC800 system uses indirect (or diluted) I.S.E. (ion selective electrode) methodology to measure calcium concentration in serum, plasma, or urine. A calcium ion selective electrode measures un-bound free calcium ions in solution. The system determines calcium concentration by measuring calcium ion activity in solution. When the sample buffer mixture contacts the electrode, calcium ions complex with the ionophore at the electrode surface. Changes in potential develop at the electrode surface as the reaction occurs. These changes in potential are referenced to a sodium reference electrode. The reference signal is used in calculating the analyte concentrations based on the Nernst equation.

Cholesterol

The DxC800 uses the timed-endpoint method to measure the cholesterol concentration in serum or plasma. In the reaction, the cholesterol esterase hydrolyzes cholesterol esters to free cholesterol and fatty acids. The free

cholesterol is oxidized to cholesten-3-one and hydrogen peroxide by cholesterol oxidase. Peroxidase catalyzes the reaction of hydrogen peroxide with 4-aminoantipyrine and phenol to produce a colored quinoneimine product. The system monitors the change in absorbance at 520 nm at a fixed-time interval. The change in absorbance is directly proportional to the concentration of cholesterol in the sample.

Creatinine

The DxC800 modular chemistry side uses the Jaffe rate method (kinetic alkaline picrate) to determine the concentration of creatinine in serum, plasma, or urine. The creatinine calibration is traceable to an isotope dilution mass spectrometry (IDMS) reference method. The method on the DxC800 is IDMS Standardized. A precise volume of sample is introduced into a reaction cup containing an alkaline picrate solution. Absorbance readings are taken at 520 nm between 19 and 25 seconds after sample injection. Creatinine from the sample combines with the reagent to produce a red color complex. The absorbance rate has been shown to be a direct measure of the concentration of the creatinine in the sample.

Creatine phosphokinase (CPK)

The DxC800 use an enzymatic rate method to determine CK activity in serum or plasma. In the reaction, the CK catalyzes the transfer of a phosphate group from the creatine phosphate substrate to adenosine diphosphate (ADP). The subsequent formation of adenosine triphosphate (ATP) is measured through the use of two coupled reactions catalyzed by hexokinase (HK) and glucose-6-phosphate dehydrogenase (G6PD) which results in the production of ß Nicotinamide Adenine Dinucleotide (reduced form) (NADH) from ß Nicotinamide Adenine Dinucleotide (NAD). The system monitors the rate of change in absorbance at 340 nm over a fixed time interval. The rate of change in absorbance is directly proportional to the activity of CK in the sample.

Gammaglutamyl Transaminase (GGT)

The DxC800 uses an enzymatic rate method to determine the GGT activity in serum or plasma. In the reaction, the GGT catalyzes the transfer of a gamma-glutamyl group from the colorless substrate, gamma-glutamyl-p-nitroaniline, to the acceptor, glycylglycine with production of the colored product, p-nitroaniline. The system monitors the rate of change in absorbance at 410 nm over a fixed-time interval. The rate of change in absorbance is directly proportional to the activity of GGT in the sample.

Glucose

On the Modular Chemistry side of the DxC800, glucose concentration in biologic fluids is determined by the oxygen rate method employing a Beckman

Oxygen electrode (glucose oxidase method). A precise volume of sample is introduced in a reaction cup containing an electrode that responds to oxygen concentration. Electronic circuits determine the rate of oxygen consumption, which is directly proportional to the concentration of glucose in the sample.

Iron

The DcX800 method used to measure the iron concentration is a timed-endpoint method. In the reaction, iron is released from transferrin by acetic acid and is reduced to the ferrous state by hydroxylamine and thioglycolate. The ferrous ion is immediately complexed with the FerroZine Iron Reagent. The system monitors the change in absorbance at 560 nm at a fixed-time interval. This change in absorbance is directly proportional to the concentration of iron in the sample.

Lactate Dehydrogenase (LDH)

The DxC800 with LD reagent (using lactate as substrate) utilizes an enzymatic rate method to measure LD activity in biological fluids. In the reaction, the LD catalyzes the reversible oxidation of L Lactate to Pyruvate with the concurrent reduction of ß Nicotinamide Adenine Dinucleotide (NAD) to ß Nicotinamide Adenine Dinucleotide (reduced form) (NADH). The system monitors the rate of change in absorbance at 340 nm over a fixed-time interval. The rate of change in absorbance is directly proportional to the activity of LD in the sample.

Phosphorus

The DxC800 system uses a timed-rate method to determine the concentration of phosphorus in serum, plasma and urine. In the reaction, inorganic phosphorus reacts with ammonium molybdate in an acidic solution to form a colored phosphomolybdate complex. The system monitors the change in absorbance at 365 nm at a fixed-time interval. This change in absorbance is directly proportional to the concentration of phosphorus in the sample.

Potassium, Chloride, & Sodium

Potassium ion concentration is measured by electrolyte activity in solution. The DxC800 system uses indirect (or diluted) I.S.E. (ion selective electrode) methodology to measure potassium in biological fluids. The potassium electrode consists of valinomycin membrane. The voltage (potential) change that takes place within the membrane follows the Nernst equation and allows the calculation of potassium concentration in solution.

Chloride is measured using an Ag/AgCl electrode. At the face of the electrode, solid AgCl dissolves to the extent as to saturate the solution around the tip with silver (Ag^+) and Chloride (Cl^-) ions until equilibrium is established. The product of the ion concentrations in solution, at equilibrium, with an excess of

the slightly soluble AgCl is defined as the solubility product constant (Ksp). When chloride sample is added, the Ksp of the solution at the tip is disrupted as AgCl precipitates out of solution. To reestablish the equilibrium, Ag^+ ions are generated from the tip causing a change in the potential. According to the Nernst equation, this change is proportional to the concentration of chloride in the sample.

Sodium is measured by the DxC800 system by utilizing indirect (or diluted) I.S.E. (ion selective electrode) methodology. The DxC800 determines sodium ion concentration in biological fluids by measuring electrolyte activity in solution. When the sample/buffer mixture contacts the electrode, sodium ions undergo an ion exchange in the hydrated outer layer of the glass electrode. As the ion exchange takes place, a change in voltage (potential) is developed at the face of the electrode. The potential follows the Nernst equation and allows the calculation of sodium concentration in a solution.

Total Bilirubin

The DxC800 uses a timed-endpoint Diazo method (Jendrassik-Grof) to measure the concentration of total bilirubin in serum or plasma. In the reaction, bilirubin reacts with diazo reagent in the presence of caffeine, benzoate, and acetate as accelerators to form azobilirubin. The system monitors the change in absorbance at 520 nm at a fixed-time interval. This change in absorbance is directly proportional to the concentration of total bilirubin in the sample.

Total Protein

The DxC800 uses a timed rate biuret method to measure the concentration of total protein in serum or plasma. Proteins in the sample combine with the reagent producing alkaline copper-protein chelate. The rate change in absorbance is monitored by a detector at 545 nm. The observed rate of chelate formation is directly proportional to the total protein concentration in the sample.

Triglycerides

The DxC800 uses a timed-endpoint method to determine the concentration of triglycerides in serum or plasma. Triglycerides in the sample are hydrolyzed to glycerol and free fatty acids by the action of lipase. A sequence of three coupled enzymatic steps using glycerol kinase (GK), glycerophosphate oxidase (GPO), and horseradish peroxidase (HPO) causes the oxidative coupling of 3,5-dichloro-2-hydroxybenzenesulfonic acid (DHBS) with 4-aminoantipyrine to form a red quinoneimine dye. The system monitors the change in absorbance at 520 nm for a fixed-time interval. The change in absorbance is directly proportional to the concentration of triglycerides in the sample.

Uric Acid

The DxC800 uses a timed endpoint method to measure the concentration of uric acid in serum, plasma or urine. Uric acid is oxidized by uricase to produce allatoin and hydrogen peroxide. The hydrogen peroxide reacts with 4-aminoantipyrine (4-AAP) and 3, 5-dichloro-2-hydroxybenzene sulfonate (DCHBS) in a reaction catalyzed by peroxidase to produce a colored product. The system monitors the change in absorbance at 520 nm at a fixed time interval. The change in absorbance is directly proportional to the concentration of uric acid in the sample.

Refer to the Laboratory Method Files section for a detailed description of the laboratory methods used.

There were no changes to the lab method, or lab site for this component in the NHANES 2015-2016 cycle. However, there was a change in lab equipment for the standard biochemistry panel analytes in the 2015-2016 cycle. In the 2013-2014 cycle, the analytes were measured on the Beckman Coulter UniCel DxC 800 Synchron chemistry analyzer. In the 2015-2016 cycle, the analytes were measured on the Beckman Coulter UniCel DxC 800 Synchron and the Beckman Coulter UniCel DxC 660i Synchron Access chemistry analyzers.

Laboratory Method Files

Creatinine - Serum (DXC 800) (September 2017)

Creatinine - Serum (DXC 660i) (September 2017)

Gamma-Glutamyl Transferase (September 2017)

Glucose (September 2017)

Iron (September 2017)

Lactate Dehydrogenase (LDH) (September 2017)

Phosphorus (September 2017)

Potassium (September 2017)

Sodium (September 2017)

Total Protein (DXC 660i) (September 2017)

Total Protein (DXC 800) (September 2017)

Triglycerides (September 2017)

Uric Acid (September 2017)

Albumin (DXC 660i) (September 2017)

Albumin (DXC 800) (September 2017)

Alkaline Phosphatase (ALP) (September 2017)

Alanine Amino Transferase (ALT) (September 2017)

Aspartate Aminotransferase (AST) (September 2017)

Bicarbonate (HCO3) (September 2017)

Bilirubin (September 2017)

Blood Urea Nitrogen (BUN) (DXC 660i) (September 2017)

Blood Urea Nitrogen (BUN) (DXC 800) (September 2017)

Total Calcium (September 2017)

Chloride (September 2017)

Cholesterol (September 2017)

Creatine Kinase (September 2017)

Laboratory Quality Assurance and Monitoring

Serum specimens are processed, stored, and shipped to the Collaborative Laboratory Services, Ottumwa, Iowa for analysis.

Detailed instructions on specimen collection and processing are discussed in the NHANES Laboratory Procedures Manual (LPM). Vials are stored under appropriate refrigerated (2-8°C) conditions until they are shipped to Collaborative Laboratory Services for testing.

The NHANES quality control and quality assurance protocols (QA/QC) meet the 1988 Clinical Laboratory Improvement Act mandates. Detailed QA/QC instructions are discussed in the NHANES LPM.

Mobile Examination Centers (MECs)

Laboratory team performance is monitored using several techniques. NCHS and contract consultants use a structured competency assessment evaluation during visits to evaluate both the quality of the laboratory work and the quality-control procedures. Each laboratory staff member is observed for equipment operation, specimen collection and preparation; testing procedures and constructive feedback are given to each staff member. Formal retraining sessions are conducted annually to ensure that required skill levels were maintained.

Analytical Laboratories

NHANES uses several methods to monitor the quality of the analyses performed by the contract laboratories. In the MEC, these methods include performing blind split samples collected during “dry run” sessions. In addition, contract laboratories randomly perform repeat testing on 2% of all specimens.

NCHS developed and distributed a quality control protocol for all CDC and

contract laboratories, which outlined the use of Westgard rules (Westgard, et al. 1981) when running NHANES specimens. Progress reports containing any problems encountered during shipping or receipt of specimens, summary statistics for each control pool, QC graphs, instrument calibration, reagents, and any special considerations are submitted to NCHS quarterly. The reports are reviewed for trends or shifts in the data. The laboratories are required to explain any identified areas of concern.

Data Processing and Editing

The data were reviewed. Incomplete data or improbable values were sent to the performing laboratory for confirmation.

There were 13 additional variables created in this data file to convert the analyzed values into International System of Units (SI). These variables were created using the following formulas:

LBXSAL conversion to LBDSALSI

Albumin in g/dL (LBXSAL) was converted to g/L (LBDSALSI) by multiplying by **10**

LBXSBU conversion to LBDSBUSI

Blood urea nitrogen (BUN) in mg/dL (LBXSBU) was converted to mmol/L (LBDSBUSI) by multiplying by **0.357**

LBXSCA conversion to LBDSCASI

Calcium in mg/dL (LBXSCA) was converted to mmol/L (LBDSCASI) by multiplying by **0.250**

LBXSCH conversion to LBDSCHSI

Cholesterol in mg/dL (LBXSCH) was converted to mmol/L (LBDSCHSI) by multiplying by **0.0259**

LBXSCR conversion to LBDSCRSI

Creatinine in mg/dL (LBXSCR) was converted to µmol/L (LBDSCRSI) by multiplying by **88.4**

LBXSGL conversion to LBDSGLSI

Glucose in mg/dL (LBXSGL) was converted to mmol/L (LBDSGLSI) by multiplying by **0.0555**

LBXSIR conversion to LBDSIRSI

Iron in µg/dL (LBXSIR) was converted to µmol/L (LBDSIRSI) by multiplying by **0.1791**

LBXSPH conversion to LBDSPHSI

Phosphorus in mg/dL (LBXSPH) was converted to mmol/L (LBDSPHSI) by multiplying by **0.323**

LBXSTB conversion to LBDSTBSI

Total bilirubin in mg/dL (LBXSTB) was converted to µmol/L (LBDSTBSI) by multiplying by **17.1**

LBXSTP conversion to LBDSTPSI

Total protein in g/dL (LBXSTP) was converted to g/L (LBDSTPSI) by multiplying by **10**

LBXSTR conversion to LBDSTRSI

Triglycerides in mg/dL (LBXSTR) were converted to mmol/L (LBDSTRSI) by multiplying by **0.0113**

LBXSTR conversion to LBDSTRSI

Uric acid in mg/dL (LBXSUA) was converted to µmol/L (LBDSUASI) by multiplying by **59.48**

LBXSGB conversion to LBDSGBSI

Globulin in g/dL (LBXSGB) was converted to g/L (LBDSGBSI) by multiplying by **10**

Analytic Notes

Refer to the 2015 - 2016 Laboratory Data Overview for general information on NHANES laboratory data.

Demographic and Other Related Variables

The analysis of NHANES laboratory data must be conducted using the appropriate survey design and demographic variables. The NHANES 2015 - 2016 Demographics File contains demographic data, health indicators, and other related information collected during household interviews as well as the sample design variables. The recommended procedure for variance estimation requires use of stratum and PSU variables (SDMVSTRA and SDMVPSU,

respectively) in the demographic data file.

The Fasting Questionnaire File includes auxiliary information, such as fasting status, length of fast and the time of venipuncture.

This laboratory data file can be linked to the other NHANES data files using the unique survey participant identifier (i.e., SEQN).

Glucose (LBXSGL)

This glucose value was obtained from the standard battery of biochemical assessments. Use of the laboratory test result from the reference method (LBXGLU), rather than the standard battery of biochemical assessments value (LBXSGL), is generally recommended. These serum glucose values (LBXSGL) reported in this data file should not be used to determine undiagnosed diabetes or prediabetes. Instead, plasma glucose values (LBXGLU) should be used, which are based on the reference analytic method in the **GLU_I** data file. Special weights included in the GLU_I data file should be used when analyzing these data.

Total Cholesterol (LBXSCH)

This total cholesterol value was obtained from the standard battery of biochemical assessments. Use of the laboratory test result from the reference method (LBXTC), rather than the standard battery of biochemical assessments value (LBXSCH), is generally recommended. For most serum cholesterol analyses, the appropriate variable to use will be (LBXTC) in the **TCHOL_I** data file. The (LBXSCH) value from the standard biochemistry profile should not be used routinely.

Triglycerides (LBXSTR)

This triglyceride value was obtained from the standard battery of biochemical assessments. Use of the laboratory test result from the reference method (LBXTR), rather than the standard battery of biochemical assessments value (LBXSTR), is generally recommended. For most triglyceride analyses, the appropriate variable to use is (LBXTR) in the **TRIGLY_I** data file. The value from the standard biochemistry profile (LBXSTR) should not be used routinely.

Detection Limits

The detection limits were constant for all of the analytes in the data set.

The lower limit of detection (LLOD) for the Standard Biochemistry Profile:

Variable Name	SAS LABEL	LLOD
LBXSATSI	Alanine Aminotransferase (ALT) (U/L)	5
LBXSAL	Albumin, refrigerated serum (g/dL)	1
LBXSAPSI	Alkaline Phosphatase (ALP) (U/L)	5
LBXSASSI	Aspartate Aminotransferase (AST) (U/L)	5
LBXSC3SI	Bicarbonate (mmol/L)	5
LBXSBU	Blood Urea Nitrogen (g/dL)	1
LBXSCLSI	Chloride (mmol/L)	50
LBXSCH	Cholesterol, refrigerated serum (mg/dL)	5
LBXSCK	Creatine Phosphokinase (CPK) (IU/L)	5
LBXSCR	Creatinine, refrigerated serum (mg/dL)	0.1
LBXSGTSI	Gamma Glutamyl Transferase (GGT) (U/L)	5
LBXSGL	Glucose, refrigerated serum (mg/dL)	3
LBXSIR	Iron, refrigerated serum (ug/dL)	5
LBDSLDSI	Lactate Dehydrogenase (LDH) (U/L)	5
LBXSPH	Phosphorus (mg/dL)	0.5
LBXSKSI	Potassium (mmol/L)	1
LBXSNASI	Sodium (mmol/L)	100
LBXSTB	Total Bilirubin (mg/dL)	0.1
LBXSCA	Total Calcium (mg/dL)	2
LBXSTP	Total Protein (g/dL)	1
LBXSTR	Triglycerides, refrig serum (mg/dL)	10
LBXSUA	Uric Acid (mg/dL)	0.5

Please refer to the NHANES Analytic Guidelines and the on-line NHANES Tutorial for further details on the use of sample weights and other analytic issues.

References

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- Westgard J.O., Barry P.L., Hunt M.R., Groth T. A multi-rule Shewhart chart for quality control in clinical chemistry. Clin Chem (1981) 27:493-501.

Codebook and Frequencies

SEQN - Respondent sequence number

Variable Name:	SEQN
SAS Label:	Respondent sequence number
English Text:	Respondent sequence number.
Target:	Both males and females 12 YEARS - 150 YEARS

LBXSAL - Albumin, refrigerated serum (g/dL)

Variable Name: LBXSAL

SAS Label: Albumin, refrigerated serum (g/dL)

English Text: Albumin, refrigerated serum (g/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
2 to 5.6	Range of Values	6256	6256	
.	Missing	488	6744	

LBDSALSI - Albumin, refrigerated serum (g/L)

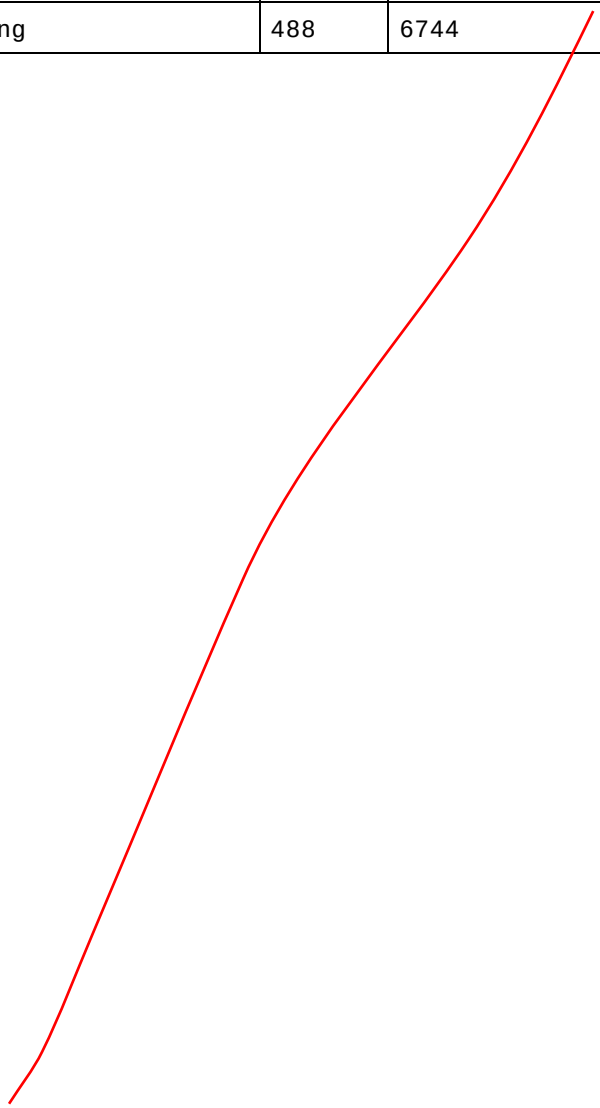
Variable Name: LBDSALSI

SAS Label: Albumin, refrigerated serum (g/L)

English Text: Albumin, refrigerated serum(g/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
20 to 56	Range of Values	6256	6256	
.	Missing	488	6744	



LBXSAPSI - Alkaline Phosphatase (ALP) (IU/L)

Variable Name: LBXSAPSI

SAS Label: Alkaline Phosphatase (ALP) (IU/L)

English Text: Alkaline Phosphatase (ALP) (IU/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
23 to 740	Range of Values	6255	6255	
.	Missing	489	6744	

LBXSASSI - Aspartate Aminotransferase (AST) (IU/L)

Variable Name: LBXSASSI

SAS Label: Aspartate Aminotransferase (AST) (IU/L)

English Text: Aspartate Aminotransferase (AST) (IU/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
8 to 832	Range of Values	6256	6256	
.	Missing	488	6744	

LBXSATSI - Alanine Aminotransferase (ALT) (IU/L)

Variable Name: LBXSATSI

SAS Label: Alanine Aminotransferase (ALT) (IU/L)

English Text: Alanine Aminotransferase (ALT) (IU/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
6 to 319	Range of Values	6256	6256	
.	Missing	488	6744	

LBXSBU - Blood Urea Nitrogen (mg/dL)

Variable Name: LBXSBU

SAS Label: Blood Urea Nitrogen (mg/dL)

English Text: Blood Urea Nitrogen (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
3 to 96	Range of Values	6255	6255	
.	Missing	489	6744	

LBDSBUSI - Blood Urea Nitrogen (mmol/L)

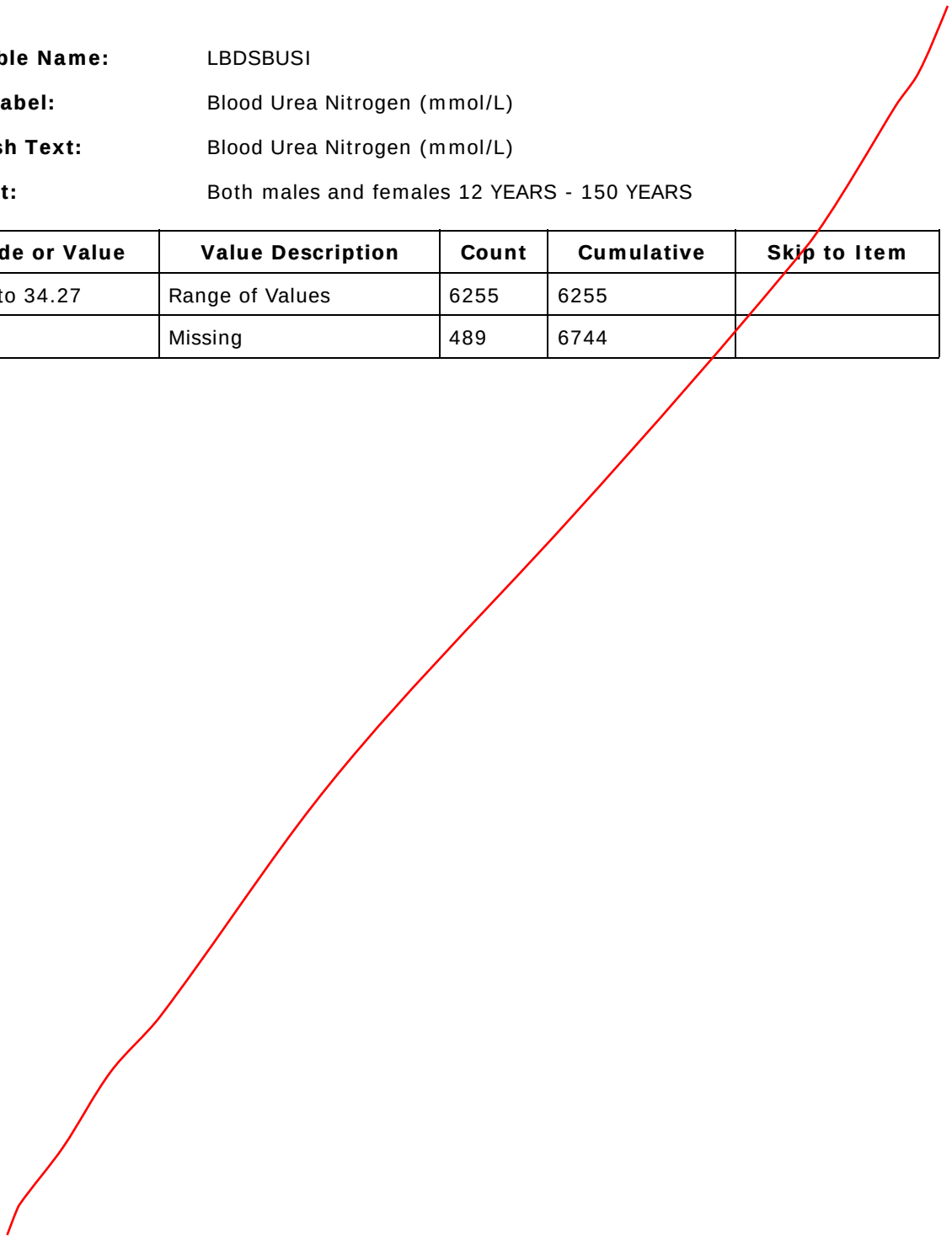
Variable Name: LBDSBUSI

SAS Label: Blood Urea Nitrogen (mmol/L)

English Text: Blood Urea Nitrogen (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1.07 to 34.27	Range of Values	6255	6255	
.	Missing	489	6744	



LBXSC3SI - Bicarbonate (mmol/L)

Variable Name: LBXSC3SI

SAS Label: Bicarbonate (mmol/L)

English Text: Bicarbonate (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
15 to 34	Range of Values	6257	6257	
.	Missing	487	6744	

LBXSCA - Total Calcium (mg/dL)

Variable Name: LBXSCA

SAS Label: Total Calcium (mg/dL)

English Text: Total Calcium (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
7.3 to 11.5	Range of Values	6257	6257	
.	Missing	487	6744	

LBDSCASI - Total Calcium (mmol/L)

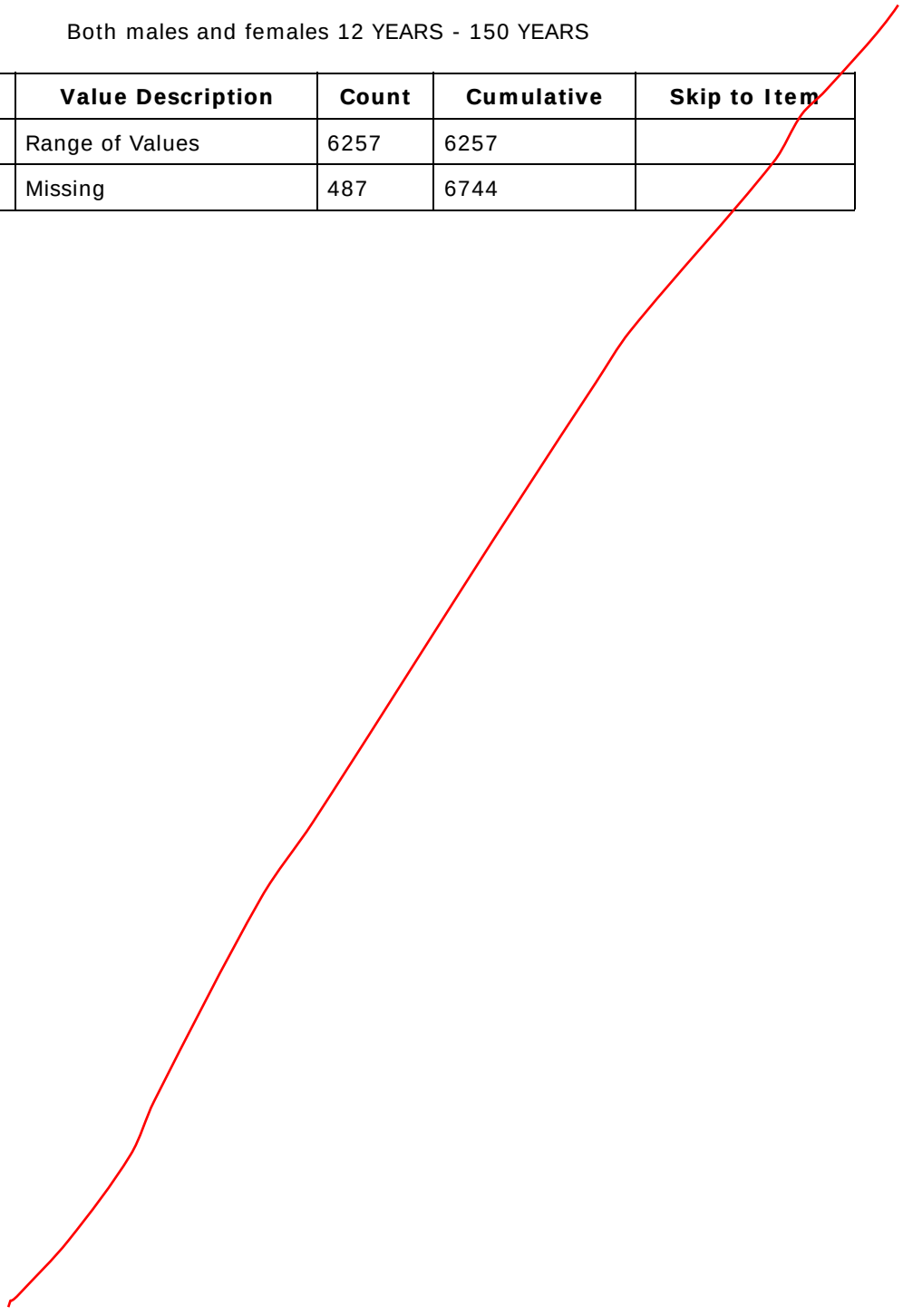
Variable Name: LBDSCASI

SAS Label: Total Calcium (mmol/L)

English Text: Total Calcium (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1.825 to 2.875	Range of Values	6257	6257	
.	Missing	487	6744	



LBXSCH - Cholesterol, refrigerated serum (mg/dL)

Variable Name: LBXSCH

SAS Label: Cholesterol, refrigerated serum (mg/dL)

English Text: Cholesterol, refrigerated serum (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
78 to 565	Range of Values	6254	6254	
.	Missing	490	6744	

LBDSCHSI - Cholesterol, refrigerated serum (mmol/L)

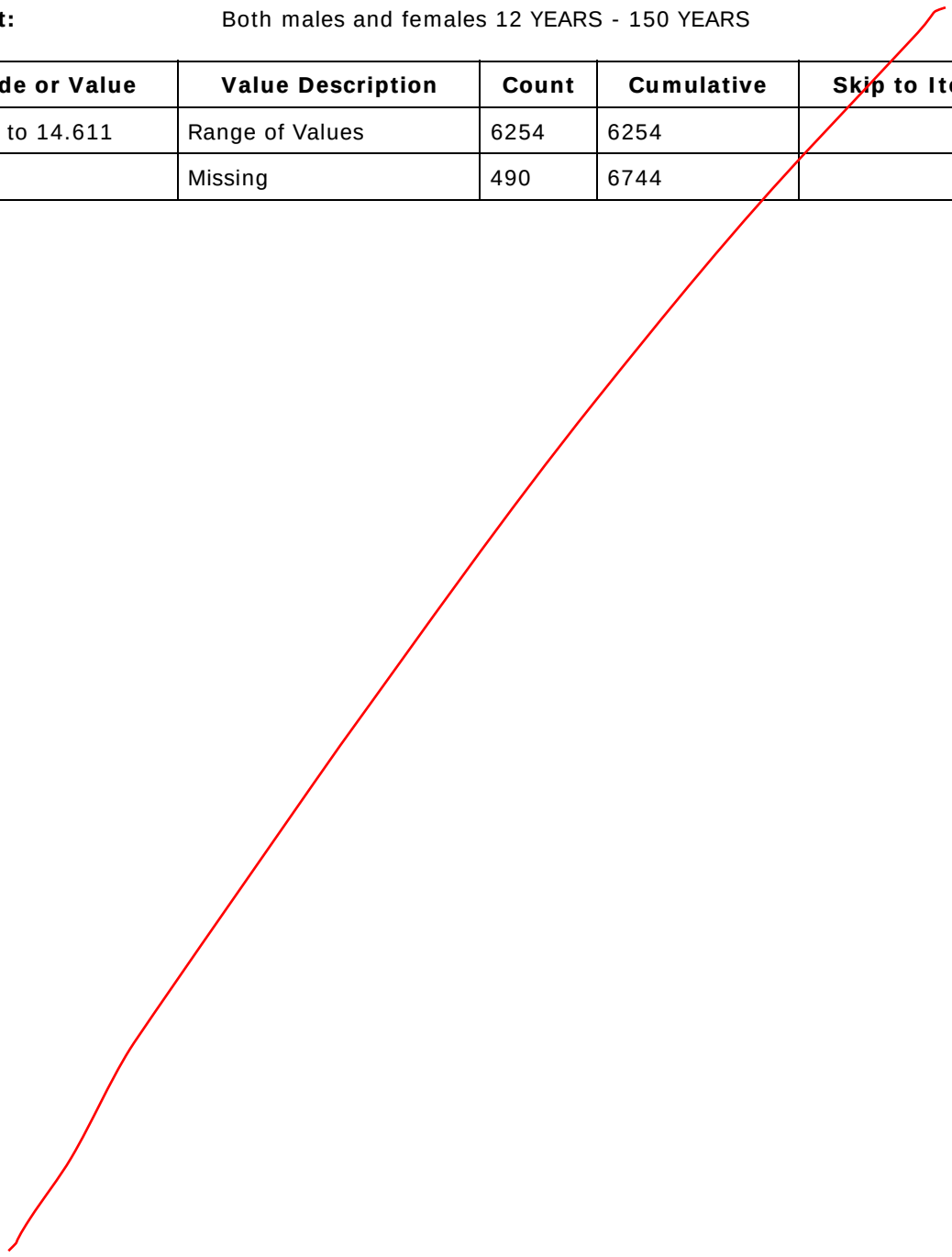
Variable Name: LBDSCHSI

SAS Label: Cholesterol, refrigerated serum (mmol/L)

English Text: Cholesterol, refrigerated serum (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
2.017 to 14.611	Range of Values	6254	6254	
.	Missing	490	6744	



LBXSCK - Creatine Phosphokinase (CPK) (IU/L)

Variable Name: LBXSCK

SAS Label: Creatine Phosphokinase (CPK) (IU/L)

English Text: Creatine Phosphokinase (CPK) (IU/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
17 to 3963	Range of Values	6248	6248	
.	Missing	496	6744	

LBXSCLSI - Chloride (mmol/L)

Variable Name: LBXSCLSI

SAS Label: Chloride (mmol/L)

English Text: Chloride (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
88 to 117	Range of Values	6257	6257	
.	Missing	487	6744	

LBXSCR - Creatinine, refrigerated serum (mg/dL)

Variable Name: LBXSCR

SAS Label: Creatinine, refrigerated serum (mg/dL)

English Text: Creatinine, refrigerated serum (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.3 to 10.71	Range of Values	6255	6255	
.	Missing	489	6744	

LBDSCRSI - Creatinine, refrigerated serum (umol/L)

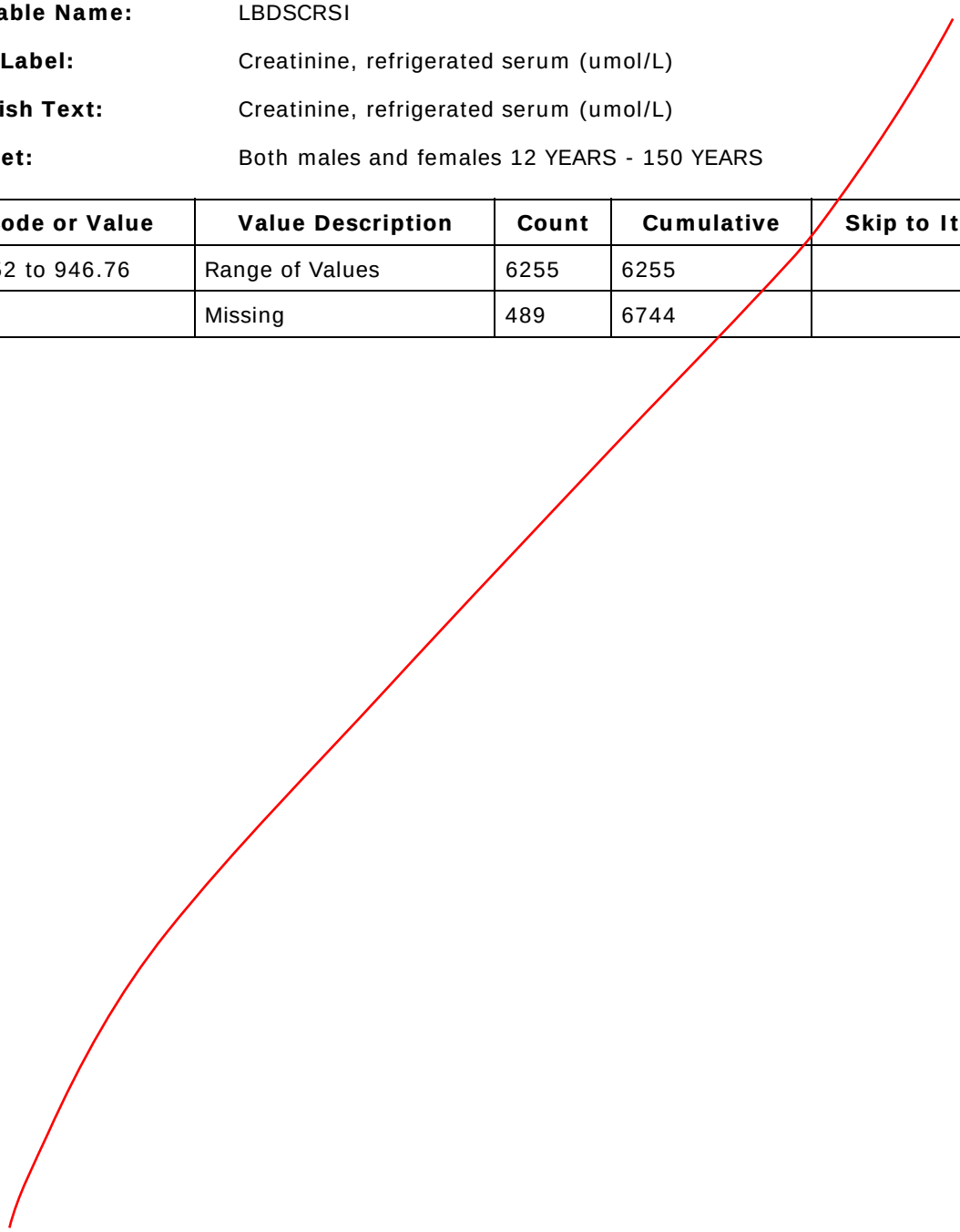
Variable Name: LBDSCRSI

SAS Label: Creatinine, refrigerated serum (umol/L)

English Text: Creatinine, refrigerated serum (umol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
26.52 to 946.76	Range of Values	6255	6255	
.	Missing	489	6744	



LBXSGB - Globulin (g/dL)

Variable Name: LBXSGB

SAS Label: Globulin (g/dL)

English Text: Globulin (g/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.6 to 7	Range of Values	6252	6252	
.	Missing	492	6744	

LBDSGBSI - Globulin (g/L)

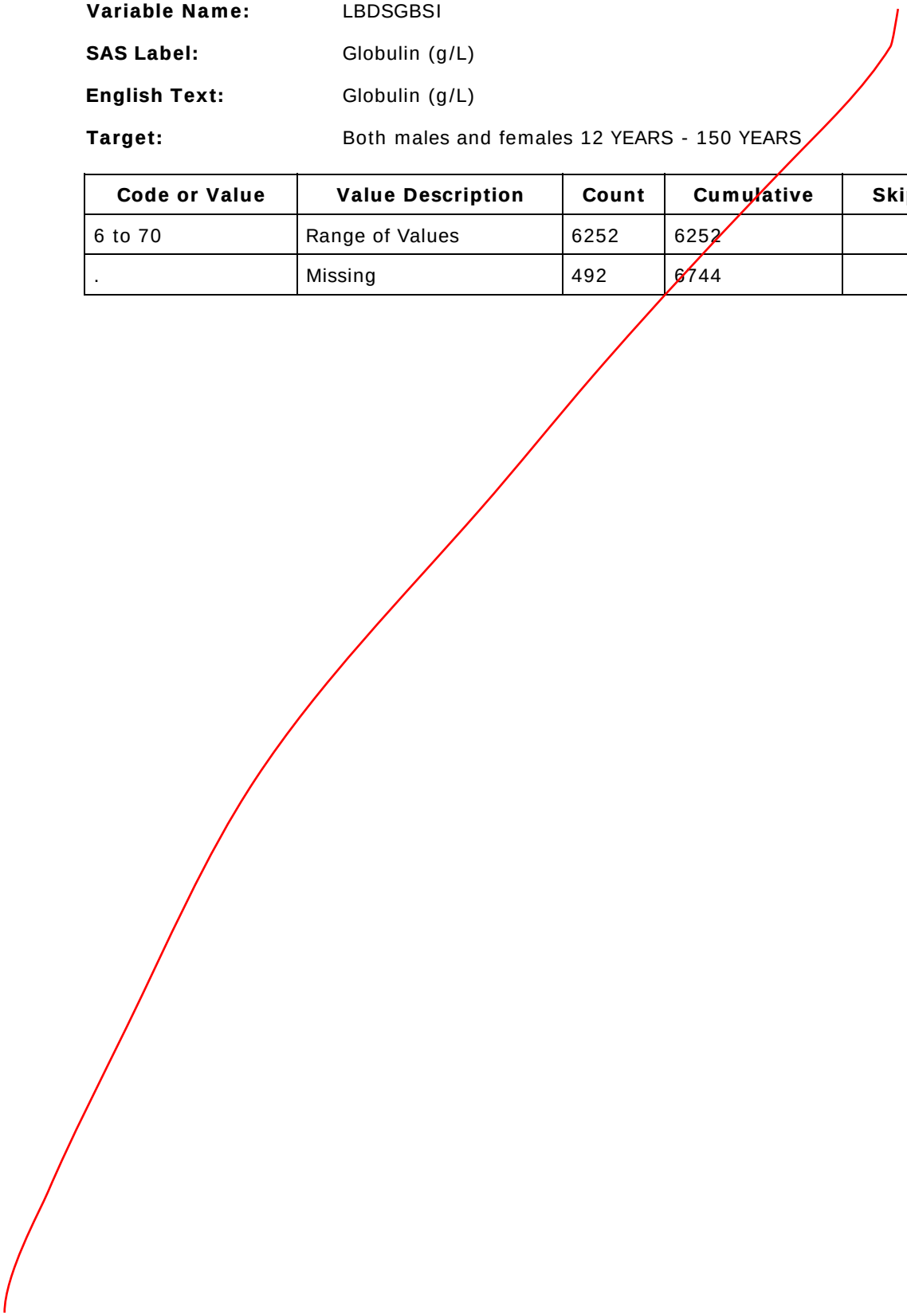
Variable Name: LBDSGBSI

SAS Label: Globulin (g/L)

English Text: Globulin (g/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
6 to 70	Range of Values	6252	6252	
.	Missing	492	6744	



LBXSGL - Glucose, refrigerated serum (mg/dL)

Variable Name: LBXSGL

SAS Label: Glucose, refrigerated serum (mg/dL)

English Text: Glucose, refrigerated serum (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
19 to 610	Range of Values	6257	6257	
.	Missing	487	6744	

LBDSGLSI - Glucose, refrigerated serum (mmol/L)

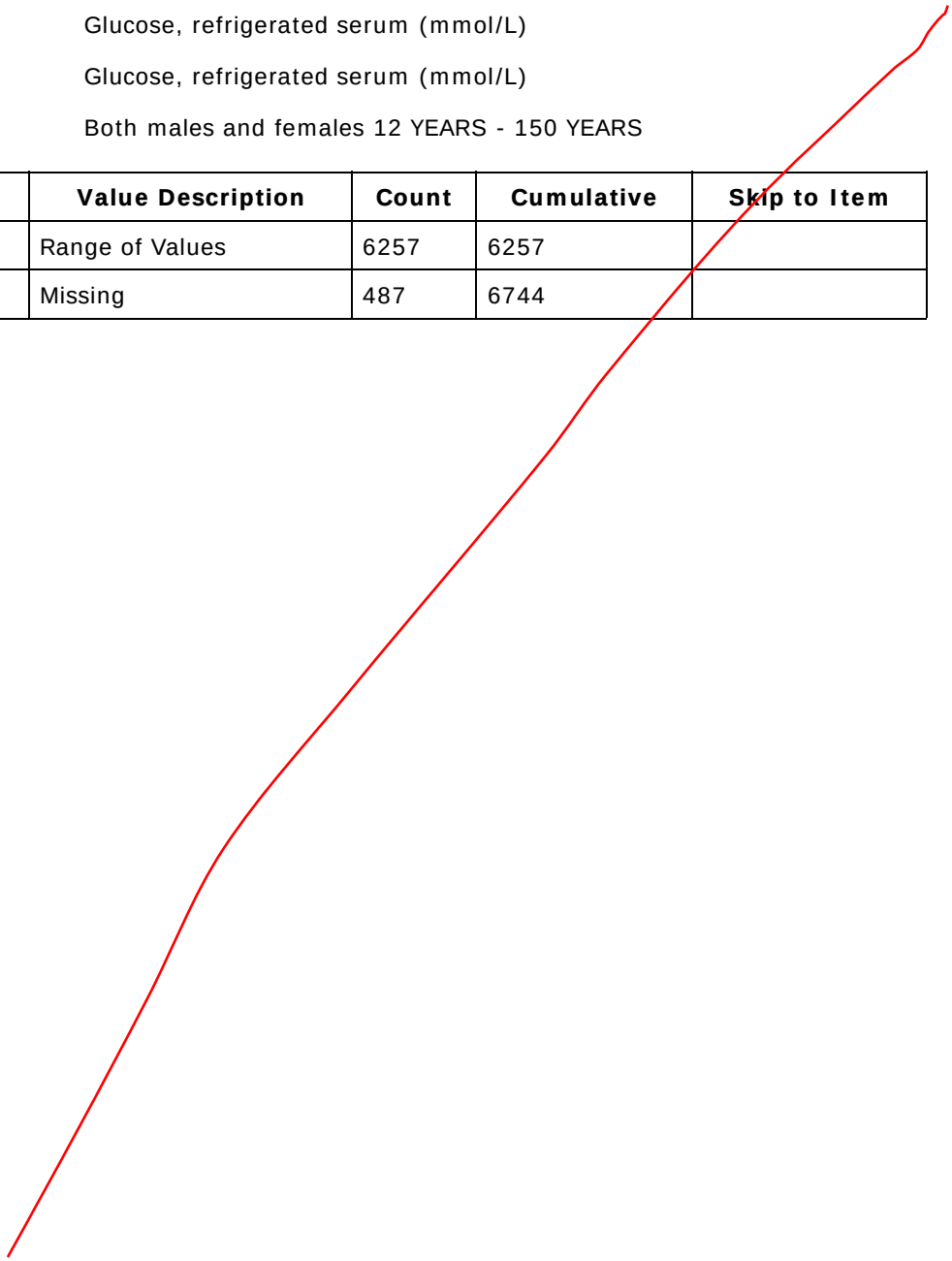
Variable Name: LBDSGLSI

SAS Label: Glucose, refrigerated serum (mmol/L)

English Text: Glucose, refrigerated serum (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1.05 to 33.86	Range of Values	6257	6257	
.	Missing	487	6744	



LBXSGTSI - Gamma Glutamyl Transferase (GGT) (U/L)

Variable Name: LBXSGTSI

SAS Label: Gamma Glutamyl Transferase (GGT) (U/L)

English Text: Gamma Glutamyl Transferase (GGT) (U/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
4 to 1487	Range of Values	6256	6256	
.	Missing	488	6744	

LBXSIR - Iron, refrigerated serum (ug/dL)

Variable Name: LBXSIR

SAS Label: Iron, refrigerated serum (ug/dL)

English Text: Iron, refrigerated serum (ug/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
2 to 286	Range of Values	6253	6253	
.	Missing	491	6744	

LBDSIRSI - Iron, refrigerated serum (umol/L)

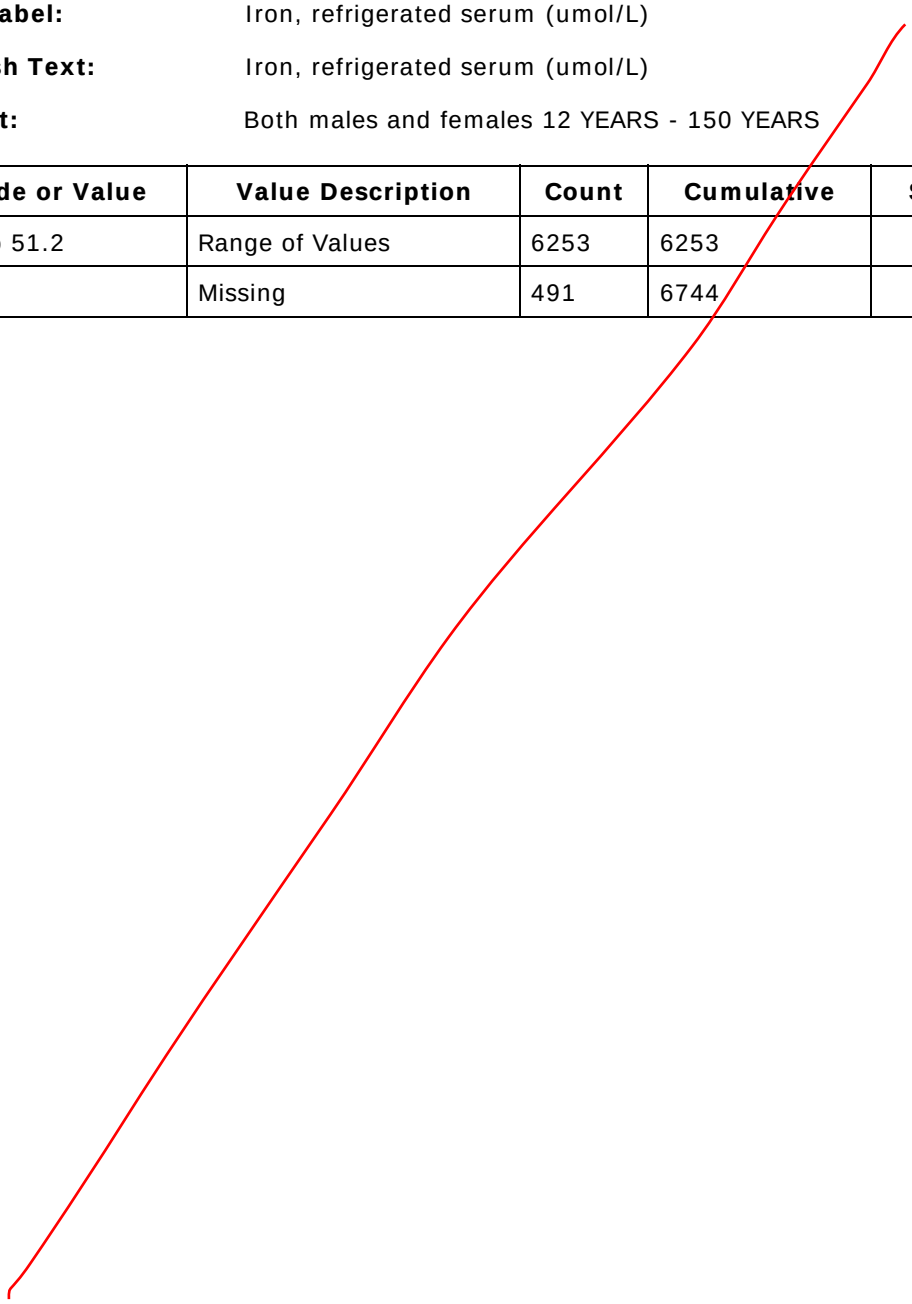
Variable Name: LBDSIRSI

SAS Label: Iron, refrigerated serum (umol/L)

English Text: Iron, refrigerated serum (umol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.4 to 51.2	Range of Values	6253	6253	
.	Missing	491	6744	



LBXSKSI - Potassium (mmol/L)

Variable Name: LBXSKSI

SAS Label: Potassium (mmol/L)

English Text: Potassium (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
2.6 to 5.86	Range of Values	6257	6257	
.	Missing	487	6744	

LBXSLDSI - Lactate Dehydrogenase (LDH) (U/L)

Variable Name: LBXSLDSI

SAS Label: Lactate Dehydrogenase (LDH) (U/L)

English Text: Lactate Dehydrogenase (LDH) (U/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
51 to 618	Range of Values	6256	6256	
.	Missing	488	6744	

LBXSNASI - Sodium (mmol/L)

Variable Name: LBXSNASI

SAS Label: Sodium (mmol/L)

English Text: Sodium (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
124 to 161	Range of Values	6257	6257	
.	Missing	487	6744	

LBXSOSSI - Osmolality (mmol/Kg)

Variable Name: LBXSOSSI

SAS Label: Osmolality (mmol/Kg)

English Text: Osmolality (mmol/Kg)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
250 to 322	Range of Values	6254	6254	
.	Missing	490	6744	

LBXSPH - Phosphorus (mg/dL)

Variable Name: LBXSPH

SAS Label: Phosphorus (mg/dL)

English Text: Phosphorus (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1 to 9.7	Range of Values	6256	6256	
.	Missing	488	6744	

LBDSPHSI - Phosphorus (mmol/L)

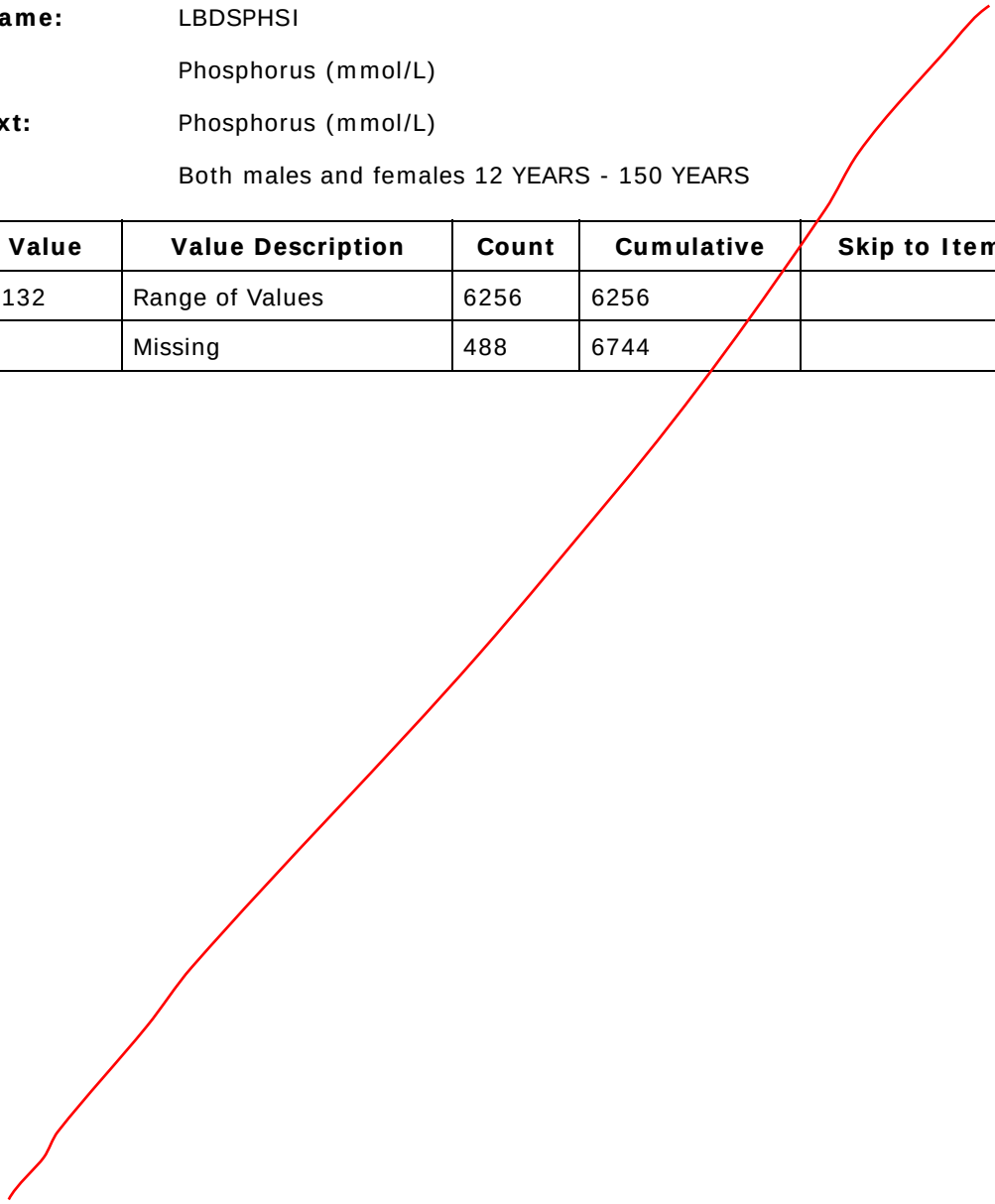
Variable Name: LBDSPHSI

SAS Label: Phosphorus (mmol/L)

English Text: Phosphorus (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.323 to 3.132	Range of Values	6256	6256	
.	Missing	488	6744	



LBXSTB - Total Bilirubin (mg/dL)

Variable Name: LBXSTB

SAS Label: Total Bilirubin (mg/dL)

English Text: Total Bilirubin (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 3.5	Range of Values	6254	6254	
.	Missing	490	6744	

LBDSTBSI - Total Bilirubin (umol/L)

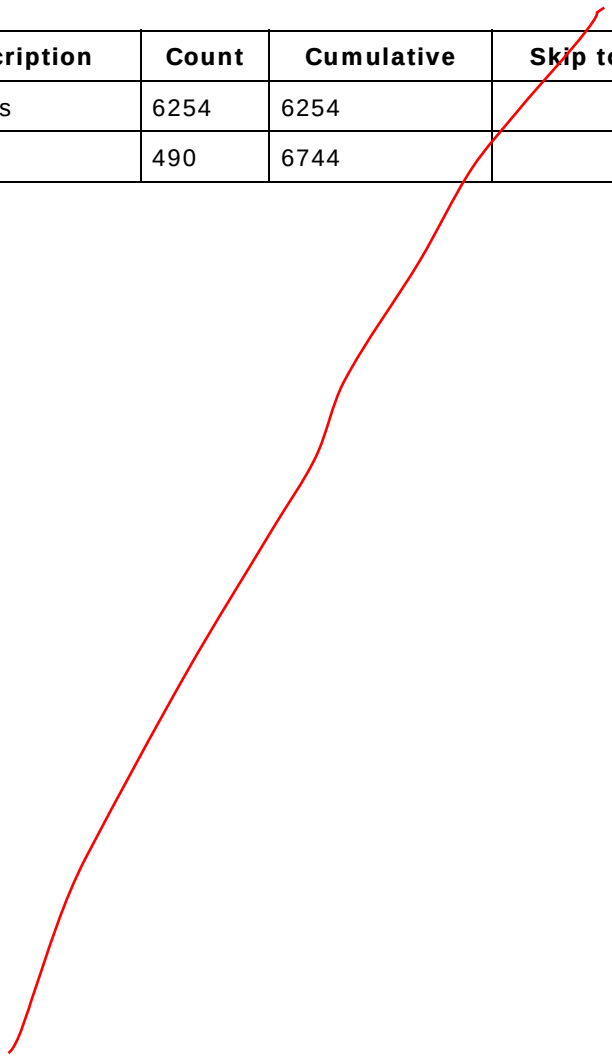
Variable Name: LBDSTBSI

SAS Label: Total Bilirubin (umol/L)

English Text: Total Bilirubin (umol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0 to 59.85	Range of Values	6254	6254	
.	Missing	490	6744	



LBXSTP - Total Protein (g/dL)

Variable Name: LBXSTP

SAS Label: Total Protein (g/dL)

English Text: Total Protein (g/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
5.2 to 10.1	Range of Values	6253	6253	
.	Missing	491	6744	

LBDSTPSI - Total Protein (g/L)

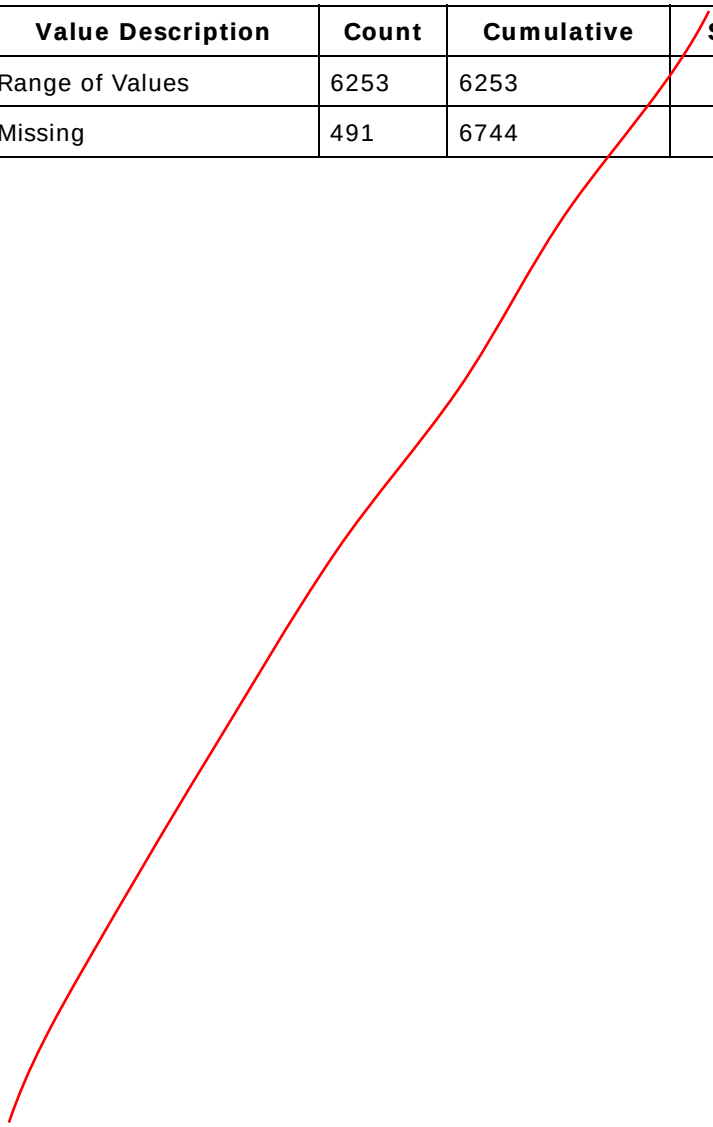
Variable Name: LBDSTPSI

SAS Label: Total Protein (g/L)

English Text: Total Protein (g/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
52 to 101	Range of Values	6253	6253	
.	Missing	491	6744	



LBXSTR - Triglycerides, refrig serum (mg/dL)

Variable Name: LBXSTR

SAS Label: Triglycerides, refrig serum (mg/dL)

English Text: Triglycerides, refrig serum (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
13 to 3061	Range of Values	6254	6254	
.	Missing	490	6744	

LBDSTRSI - Triglycerides, refrig serum (mmol/L)

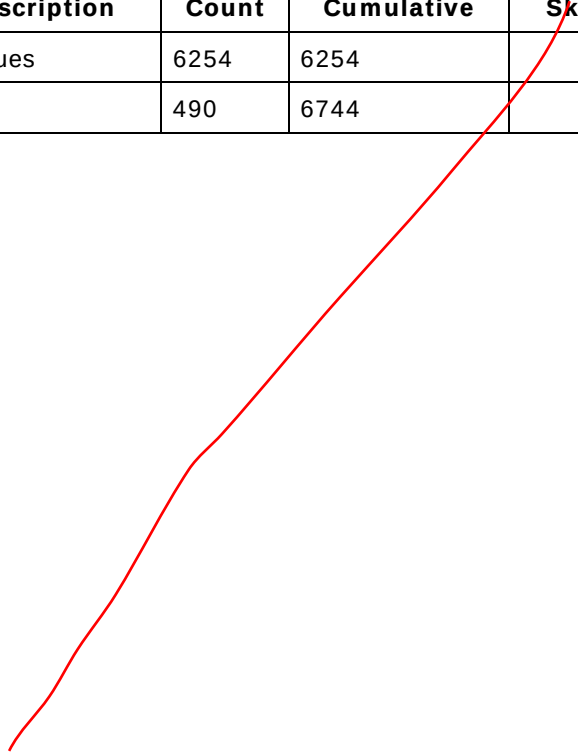
Variable Name: LBDSTRSI

SAS Label: Triglycerides, refrig serum (mmol/L)

English Text: Triglycerides, refrig serum (mmol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.147 to 34.559	Range of Values	6254	6254	
.	Missing	490	6744	



LBXSUA - Uric acid (mg/dL)

Variable Name: LBXSUA

SAS Label: Uric acid (mg/dL)

English Text: Uric acid (mg/dL)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
1.6 to 18	Range of Values	6254	6254	
.	Missing	490	6744	

LBDSUASI - Uric acid (umol/L)

Variable Name: LBDSUASI

SAS Label: Uric acid (umol/L)

English Text: Uric acid (umol/L)

Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
95.2 to 1070.6	Range of Values	6254	6254	
.	Missing	490	6744