GLUCOSE TOLERANCE AMONG RURAL AND URBAN FULANI OF NORTHERN NIGERIA

BY

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DECLARATION

I hereby declare that the writing and execution of the study contained in this dissertation was carried out by me. The work is original and has not been submitted for any publication before.

Signature -------------------------------

Dr. Anas Ahmad Sabir

DEDICATION

This research work is dedicated to my wife Amina and my son Ahmad who endured during my residency training.

SUPERVISION

I certify that this study was carried out by Dr. Anas Ahmad Sabir under my supervision.

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ABSTRACT

BACKGROUND

The Fulani are a largely nomadic people known for covering great distances on foot with a resulting lean physique and presumably low incidence of diabetes mellitus. However, with modernization some Fulani have adopted sedentary lifestyles, western diet and white collar occupations which are risk factors for diabetes mellitus and related non-communicable diseases. The prevalence of diabetes mellitus is rising worldwide with urbanization and sedentary lifestyle being major risk factors. There is paucity of data on the glucose tolerance status among the Fulani ethnic group. The objective of this study was to determine the prevalence and lifestyle, anthropometric and biochemical risk factors for glucose intolerance among the Fulani ethnic group in Northern Nigeria.

RESEARCH DESIGN AND METHODS – Seven hundred and eighty -two subjects were recruited for the study using a multi-stage sampling method. Three hundred and ninety- three subjects were rural dwellers while three hundred and eighty-nine were urban dwellers. Using a modification of the WHO STEPS, information on socioeconomic and demographic data and risk factors for glucose intolerance (exercise, diet, alcohol consumption and cigarette smoking) was obtained by means of a questionnaire administered by a trained assistant. Each subject was briefly examined and blood pressure and

anthropometric measurements including height, weight, waist and hip circumference made. Casual or fasting plasma glucose was obtained in all subjects while plasma lipids and insulin and oral glucose tolerance were assessed in a selected group of 100 subjects. Glucose intolerance was defined using WHO criteria while insulin resistance was estimated using HOMA-IR. Raw data were entered into a spreadsheet (Microsoft Excel 2003) and exported to Epi-Info version 3.3.2 where necessary. Statistical analysis was performed using Epi-Info version 3.3.2. Significance of differences between group means was assessed using Student's t – test while χ^2 statistic was employed to determine significance of results of comparison of proportions between groups. Average values are presented as mean (SD). Level of statistical significance is set $p<0.05$.

RESULTS – Of the 800 subjects recruited into the study, 782 subjects [376(48.1%) females and 406(51.9%) males] completed the study, giving a response rate of 97.7%. There was no significant difference between the proportions of males and females ($p>0.05$). The mean (SD) age of the rural subjects was 38.5(13.6) years and that of the urban was 39.4(14.2) years ($p= 0.45$). The mean (SD) weight of the urban subjects [65.9(12.9)] kg was significantly higher than the rural subjects [58.5(9.7)] kg ($p<0.05$). The mean (SD) BMI of the urban subjects [24(4.2)] kg/m^2 was significantly higher than the rural subjects [21.9(3.1)] kg/m^2 ($p<0.05$). The mean (SD) waist circumference of the urban subjects [84.3(10.6)] cm was significantly higher than the mean waist circumference of the rural subjects [78.6(8.7)] cm ($p<0.05$). The risk factors for diabetes mellitus were higher in the urban than the rural subjects. The major risk factors for diabetes mellitus and glucose intolerance from this study were increased age and obesity. The mean (SD) FPG of the urban subjects [5.37(1.8)] mmol/l was significantly higher than the rural subjects [5.02(0.59)] mmol/l ($p<0.05$). The urban subjects had higher plasma post glucose load [6.5(1.6)] mmol/l than the rural subjects [6.3(1)] mmol/l but not statistically significant ($p= 0.45$). The mean fasting plasma insulin levels were significantly higher in the urban [16.1(15.9)] µU/ml than the rural subjects [13.2(13.6)] µU/ml ($p=0.041$). The mean HOMA-IR level was significantly higher in the urban [4.22(5)] than the rural subjects [2.32(2.5)] ($p=0.024$). The prevalence of type 2 Diabetes Mellitus in Sokoto was 2.7% with urban and rural populations having prevalence rates of 4.6% and 0.8% respectively. The prevalence of impaired fasting glycaemia was 14.9% significantly higher in urban (16.9%) than in rural (12.7%) locations ($p = 0.002$). The prevalence of insulin resistance was 23% with urban and rural populations having prevalence rates of 30% and 16% respectively.

CONCLUSIONS - The prevalence of diabetes mellitus in the Fulani of North western Nigeria was higher than the overall previous national prevalence indicating increasing prevalence of diabetes mellitus in Nigeria. The prevalence of glucose intolerance and its risk factors were higher in the urban Fulani than the rural Fulani. The prevalence of insulin resistance was higher in the urban community than the rural community. There is need for prospective studies in the glucose intolerant subjects and insulin resistant subjects in order to monitor for the development of diabetes mellitus.

The results underline the need to increase public screening and to emphasize the value of lifestyle modification toward traditional African lifestyle.

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ABBREVIATIONS

ADA – American Diabetes Association

BMI – Body mass index

CPG – casual plasma glucose

DBP – Diastolic blood pressure

DM – Diabetes Mellitus

ELISA – Enzyme linked immunosorbent assay

FPG – Fasting Plasma Glucose

HDL – High density lipoprotein cholesterol

HOMA-IR – Homeostatic model assessment of insulin resistant

IDF – International diabetes federation

IFG – Impaired fasting glycaemia

IGT – Impaired glucose tolerance

IR – Insulin resistance

LDL – Low Density Lipoprotein Cholesterol

OGTT – Oral glucose tolerance test

SBP – Systolic Blood Pressure

TC – Total cholesterol

TG – Triglyceride

WC – Waist Circumference

WHO – World Health Organization

WHR – Waist-Hip Ratio

CHAPTER ONE

1. INTRODUCTION

1.1 BACKGROUND

Diabetes Mellitus (DM) is a metabolic disorder of multiple aetiology characterised by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both[1].

Epidemiological studies reveal rising rates of type 2 diabetes mellitus worldwide, notably in countries undergoing epidemiological transition from communicable to chronic diseases[2]. This has been observed in certain populations that have undergone relatively rapid transition from rural to urban lifestyles[3]. Studies in low-income and middle-income countries have identified that risk factors for chronic diseases are more prevalent in urban than rural areas[4].

There is a large variability in the occurrence of type 2 diabetes mellitus, even within the same racial and ethnic group. This may be accounted for by differences in environmental factors such as physical inactivity, obesity, diet, stress and urbanization[5].

1.2 CLASSIFICATION OF DIABETES MELLITUS

The classification of diabetes mellitus as proposed by the American Diabetes Association (ADA) and adopted in 1999 by the World Health Organization (WHO) categorises diabetes mellitus on the basis of aetiology and pathogenesis[1]. The classification is as summarized in table 1.

Table 1- classification of diabetes mellitus

Type 1 diabetes mellitus
Autoimmune
Idiopathic
Type 2 diabetes mellitus
Predominantly insulin resistance
Predominantly insulin secretory defect
Other specific types
Genetic defects of beta cell function
Genetic defects of insulin action
Diseases of the exocrine pancreas
Infections
Endocrinopathies
Uncommon forms of immune-mediated diabetes
Other genetic syndromes sometimes associated with diabetes

Drugs
Gestational diabetes mellitus

1.3 DIAGNOSTIC CRITERIA

The diagnosis of diabetes mellitus according to World Health Organization (WHO)[1] is based on the criteria in Table 2.

Table 2- Diagnostic criteria for diabetes mellitus

Diabetes mellitus
Fasting plasma glucose >126 mg/dl (7.0 mmol/l)
or Two-hour plasma glucose >200mg/dl (11.1 mmol/l) during standard 75mg oral glucose tolerance test.
or Random plasma glucose >200 mg/dl (11.1 mmol/l) plus symptoms of diabetes
Impaired glucose tolerance
Two hour post prandial plasma glucose >140 mg/dl (7.8mmol/l) but less than 200 mg/dl (11.1 mmol/l).

Impaired fasting glucose

Fasting plasma glucose >110 mg/dl (6.1 mmol/l) but less than 126 mg/dl (7.0 mmol/l).

The fasting plasma glucose is preferred because of ease of administration, convenience, acceptability to patients and lower cost.

A major change from the previous criteria is the lowering of the cut-off level of fasting plasma glucose from >140mg/dl (7.8 mmol/l) to >126mg/dl (7.0 mmol/l) in the current diagnostic criteria.

A new diagnostic category, impaired fasting glucose (IFG) was added to impaired glucose tolerance. Both of them refer to a stage intermediate between normal glucose homeostasis and diabetes.

Impaired fasting glucose refers to a level of plasma glucose after an overnight fast that is greater than 110 mg/dl (6.1 mmol/l) but less than the level of 126 mg/dl (7.0 mmol/l). Impaired glucose tolerance refers to 2 hour post prandial plasma glucose greater 140 mg/dl (7.8 mmol/l) but less than 200 mg/dl (11.1 mmol/l).

1.4 EPIDEMIOLOGY OF DIABETES MELLITUS IN DEVELOPING COUNTRIES

The prevalence of diabetes in developing countries is on the increase. The WHO predicts that developing countries will bear the burden of this epidemic in the 21st century, with more than 70% of all new cases of diabetes expected to appear in developing nations[2]. Between 1995 and 2025 the number of the adult population affected by diabetes mellitus in developing countries is projected to grow by 170%, from 84 to 228 million people[2]. Most cases of diabetes in developing countries remain undiagnosed, hence many patients with diabetes present for the first time with complications.

1.5 **FULANI**

The Fulani is an ethnic group in sub-Saharan Africa. They are scattered in many countries in West and Central Africa from Senegal, Mauritania, Guinea, The Gambia, Mali, Nigeria, Sierra Leone, Burkina Faso, Cameroon, Cote d'voire, Niger, Togo, Ghana, Liberia, to as far as Sudan in the East with a population exceeding 15 million[6]. They are traditionally nomadic people who move from place to place seasonally covering long distances on foot in search of pasture for their herds. The movements are based upon the availability of green pasture supply for their herd. The cattle are rarely eaten and remain a symbol of wealth, the sheep and goats are used for trade in the villages to obtain rice, millet, corn, clothing, etc. They are the only major migrating people of West Africa, though most Fulani now live in towns or villages. They are usually fair-skinned, tall and have lean physique. Some of these characteristics presumably may confer on them a low risk for type 2 diabetes mellitus.

1.6 AIM AND OBJECTIVES

1.6.1 AIM

To assess the status of and risk factors for glucose intolerance among the Fulani ethnic group in Northern Nigeria.

1.6.2 Specific Objectives

- To determine the pattern of glucose tolerance among the Fulani.
- To determine and compare the prevalence of risk factors for diabetes mellitus in urban and rural Fulani.

- To determine the relationship between lifestyle indices and glucose tolerance among urban and rural Fulani.
- To determine the prevalence of insulin resistance among the Fulani.

1.7 JUSTIFICATION FOR THE STUDY

The prevalence of diabetes mellitus is rising worldwide with urbanization and sedentary lifestyle being risk factors[2,4]. There is paucity of data on the prevalence of diabetes mellitus and impaired glucose tolerance among the Fulani ethnic group. The Fulani are a largely nomadic people known for covering great distances on foot with a resulting lean physique and presumably low incidence of diabetes mellitus and cardiovascular diseases. However, with modernization some Fulani have adopted sedentary lifestyle, western diet and white collar occupations which are risk factors for diabetes mellitus. In depth knowledge into the prevalence of DM and impaired glucose tolerance with associated risk factors will be of clinical and scientific value in the treatment, prevention and possible intervention in the management of diabetes mellitus.

2. LITERATURE REVIEW

CHAPTER TWO

2. LITERATURE REVIEW

2.1 PREVALENCE OF DIABETES MELLITUS

Global prevalence

Globally the number of people with diabetes is expected to rise from 194 million in 2003 to 333 million in 2025[7]. Most of this epidemic is projected to be in the developing countries. An alarming increase in the prevalence of diabetes mellitus has occurred in various populations with Pima Indians in the United States of America having a prevalence of nearly 50%[5].

Africa

Diabetes mellitus was previously considered as a rare medical condition in Africa. However epidemiological studies carried out in the last decade of the 20th century have provided evidence of global trend towards increase of the prevalence of diabetes mellitus in African populations[2]. The prevalence of diabetes mellitus in Africa is increasing with ageing of the population and lifestyle changes associated with rapid urbanization and westernization[8]. Indeed Africa is experiencing one of the most rapid demographic and epidemiological transitions in the world's history[2]. This trend is characterized by a tremendous rise in the burden of non-communicable diseases arising from increased life expectancy, sedentary lifestyle, "western" diet and reduction of infectious diseases.

Traditional rural communities still have low prevalence of diabetes mellitus whereas more adults in urban communities have diabetes mellitus[8].

The prevalence rate of diabetes mellitus in Africa ranges from 0.5-7% depending on the place and method of study[7].

The world

The Asia – Pacific region is at the forefront of the current epidemic of diabetes mellitus. There are currently more than 50 million people with diabetes in Western Pacific alone[7]. The risk for diabetes mellitus appears to result from a combination of genetic predisposition and lifestyle changes. Diabetes mellitus in India is predicted to rise from an estimated 35.5 million in 2003 to 73.5 million by 2025[7]. In China, it is predicted to rise from 23.8 million to 46.1 million by 2025[7]. Thus, more than 30% of the global burden of diabetes mellitus in 2025 will be in these 2 countries alone[7].

The Micronesian population of Nauru exhibits an age-standardized diabetes mellitus prevalence of more than 40% which is exceeded only by the Pima Indians of Arizona USA[9]. The situation in Nauru demonstrates the potential effects of modernization, high energy intake, and reduced physical activity on diabetes in a genetically susceptible population[9].

In Europe diabetes mellitus is a relatively common disorder with prevalence rates of 6.2% and 6.6% in France and Italy respectively[7].

2.2 Prevalence of Diabetes in Nigeria

The national survey on non-communicable diseases in Nigeria reported the prevalence of diabetes mellitus in Nigeria to be 2.2% with highest prevalence in urban community of Lagos mainland (7.2%) and lowest prevalence in rural community of Mangu, Plateau state (0.6%)[10]. Ohwovoriole et al[11] reported a prevalence of 1.5% and 1.9% in males and females respectively in a survey of Lagos metropolis. The prevalence of 4.1% and 2.4% in males and females respectively was found at Jos[12]. Bakari et al[13] found a prevalence of 1.6% in a suburban Northern Nigerian population.

2.3 **RISK FACTORS FOR DIABETES MELLITUS**

Type 2 diabetes mellitus occurs in genetically predisposed individuals who are exposed to environmental influences that promote the onset of clinical disease[4]. The risk factors responsible for the development of type 2 DM are outlined below:

- Genetic factors - Genetic markers, family history, “thrifty” gene
- Demographic characteristics - Advancing age, ethnicity
- Behavioural and lifestyle-related risk factors - Obesity (including distribution of obesity and duration), Physical inactivity, Diet, Stress, Urbanization/modernization
- Metabolic determinants - Impaired glucose tolerance, Insulin resistance.

2.3.1 OBESITY

The association between obesity and type 2 diabetes mellitus has been recognized for decades. Obesity has been implicated as a risk factor for diabetes mellitus in both case-control and cross-sectional studies[14,15]. The risk of diabetes mellitus rose exponentially with increasing body mass index (BMI) in a large cohort study of US women followed for 14 years[16]. Similar findings have been reported in men[17]. An association of risk with increasing weight was evident even within the non obese range[16].

A pattern of centrally distributed body fat (visceral adiposity) appears to increase the risk of type 2 diabetes more than does a similar degree of excess that is more uniformly distributed[16,18]. Though most studies used BMI as a measure of obesity, indices of visceral obesity such as waist-hip ratio and waist circumference are better predictors of type 2 diabetes mellitus[18]. Intra-abdominal fat is more lipolytically active than subcutaneous fat because of its greater complement of adrenergic receptors[19]. In addition, the abdominal adipose store is resistant to the anti-lipolytic effects of insulin[20]. Elevated free fatty acids also predict the progression from impaired glucose tolerance to diabetes mellitus[21].

2.3.2 PHYSICAL INACTIVITY

There is an inverse relationship between physical activity and the risk of type 2 diabetes mellitus. The risk of type 2 diabetes mellitus decreased with increasing amount of exercise[22,23]. Several studies have confirmed the beneficial effects of exercise especially among those who were obese or had a family history of diabetes[16,22].

In the Physicians' Health Study, a protective effect of exercise against type 2 diabetes mellitus was demonstrated[23]. The Nurses Health Study showed that the protective effect of exercise against type 2 diabetes mellitus was similar in obese and non obese individuals and in those with and without a family history of diabetes mellitus[24].

Exercise results in increase in insulin sensitivity and can delay or prevent the onset of type 2 diabetes mellitus in those at high risk[22].

Exercise induced insulin sensitivity has been attributed to up-regulation of glucose transporter number, change in capillary density, and increase in the number of red glycolytic (type IIa) fibers[25].

2.3.3 CIGARETTE SMOKING

A positive association between cigarette smoking and risk of type 2 diabetes mellitus has emerged from prospective studies[26,27]. Cigarette smoking is an independent modifiable risk factor for type 2 diabetes mellitus[27]. In a large prospective study, current smoking was associated with a 20-40 percent increased risk of diabetes mellitus of which 99% was type 2 diabetes mellitus[28].

Smoking increases serum glucose level after oral glucose load and impairs insulin sensitivity[29]. Chronic hypoxia caused by carbon monoxide in smoke and an increased tendency for platelet aggregation might play a role in diabetic microangiopathy[30].

Smoking is a risk factor for stroke, progression of albuminuria to proteinuria, and nephropathy in both type 1 and type 2 diabetes mellitus patients[31]. However, the effects of smoking on diabetic retinopathy are unclear, because some studies have suggested an association whereas others have not[31,32].

2.3.4 INSULIN RESISTANCE

Insulin resistance is a consistent finding in patients with type 2 diabetes mellitus, and is present years before the onset of diabetes[33]. Prospective studies showed that insulin resistance predicts onset of diabetes mellitus[33]. Furthermore, conditions associated with the development of insulin resistance, especially obesity and advancing age, greatly increase the risk of type 2 diabetes mellitus. Insulin resistance is strongly associated with central obesity than with more generalized obesity[34].

Insulin resistance and hyperinsulinaemia are also associated with hypertension, hypertriglyceridemia, decreased high-density lipoprotein cholesterol and increased risk of atherosclerosis and cardiovascular disease[35]. The association of insulin resistance with these features has been referred to as the Metabolic syndrome or Syndrome X[35].

There is a strong influence of environmental factors on the genetic predisposition to insulin resistance and therefore to diabetes mellitus[36].

2.3.5 URBANIZATION

When urbanization occurs, traditional diets tend to change to diets of refined, low fibre, calorie dense meals[37]. Rural populations rely on foot walk as transportation means and often have intense agricultural activities as their main occupation. Modernization tends to decrease physical activity as very little physical activity is required for daily living. Riding in a car, watching television and movies, playing video games, and sitting at computers that are common in urban areas require very little muscle movement. The change to modern/western diets and sedentary lifestyle has resulted in a positive energy balance with increased body weight and adiposity[38]. Obesity is at least 4 times higher in urban areas compared to rural areas[39].

In 2003, the number of people with diabetes in urban areas was 78 million compared to 44 million persons with diabetes in rural areas. By 2025, it is expected that this discrepancy will increase to 182 million urban and 61 million rural persons with diabetes[7].

The study of prevalence of type 2 diabetes mellitus in Pima Indians in Mexico and the USA presents a striking example of the variation in the prevalence of type 2 diabetes mellitus found in populations of similar genetic background but in different environmental circumstances[40]. The much lower prevalence of type 2 diabetes mellitus and obesity in Pima Indians in Mexico than in the USA indicates that even in a population genetically prone to these conditions, the development of diabetes is determined mostly by environmental circumstances. There is compelling evidence that changes in lifestyle associated with westernization play a role in the global epidemic of type 2 diabetes mellitus[40].

The situation in Papua New Guinea provides another classic example of the effects of rapid urbanization on prevalence of diabetes mellitus and the extreme urban-rural gradient which can result[41]. Reports by King et al[41] demonstrated prevalence rates close to 0% in highland populations. However, in urbanized Koki people the rate exceeds 40% approaching that of Nauru. Intermediate rates are seen in rural and semi rural communities. A similar situation also exists in the Solomon Islands[41].

2.3.6 THRIFTY GENE

James Neel[42] in 1962 proposed the "thrifty" genotype hypothesis to explain why diabetes mellitus occurs at high rates in some populations especially during modernization. This thrifty genotype model explains why excessive calorie intake as well as elevated insulin secretion had enabled the populations of hunter-gatherers to survive sporadic food availability under feast and famine conditions. It postulates that some cases of type 2 diabetes mellitus and obesity are derived from normal genetic actions that were once important for survival. The thrifty gene regulates hormonal fluctuations to accommodate seasonal changes. Bindon and Baker in 1997 stated that when insulin is released by the beta cells of the pancreas because of the presence of circulating glucose, an intricate biochemical response begins. The response is different for individuals with the thrifty genotype[43]. In periods of feast, hypersecretion of insulin by the beta cells allows a more efficient storage of the caloric excess. This stored excess is available for use when there is a deficit in available caloric intake. Since modernization has made high carbohydrate and fatty foods available all year long, the gene no longer serves a useful function and is now harmful because, fat originally stored for famine situations is not used up. This theory can explain the high incidence of type 2 diabetes mellitus and obesity found in Pima Indians and other Native American tribes with nomadic histories characterized by food lack and followed by western dietary habits.

2.3.7 MALNUTRITION

Malnutrition was incriminated as an aetiological factor for diabetes mellitus and the disease was called malnutrition related diabetes mellitus. The 1985 WHO technical report on diabetes recognised tropical diabetes as a specific type[44]. Two main types were recognised: the protein deficiency pancreatic disease and the fibrocalculous pancreatic disease. The main characteristics are severe hyperglycaemia, onset before the age of 30 years, body mass index under 18 kg/m^2, absence of ketosis when insulin is withdrawn, high daily needs of insulin (>1.5 IU/kg/day), poor socioeconomic status or history of childhood malnutrition, inconstant abdominal pains, and pancreatic calcification in the absence of heavy alcohol. However evidence is still sparse on the pathogenesis. McMillan et al.[45] observed that the areas with high prevalence of tropical diabetes coincided with parts of the world where cassava served as staple food and the hypothesis that cyanogenic glycosides may cause damage to pancreatic islets was drawn. In malnutrition, cyanide may not be detoxified and therefore cause damage to the pancreas and to the thyroid gland.

2.3.8 IMPAIRED GLUCOSE TOLERANCE AND IMPAIRED FASTING GLYCAEMIA

Impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG) form an intermediate state in the natural history of diabetes mellitus[46]. These terms have replaced previous terms such as “borderline” or “chemical” diabetes.

Impaired glucose tolerance is defined as 2 hour glucose levels of 140 to 200 mg/dl (7.8-11.0 mmol/l) on 75 grams oral glucose tolerance test. Impaired fasting glycaemia is defined as glucose levels of 110 to 125 mg/dl (6.1-6.9 mmol/l) in the fasting patients. These glucose levels are above normal but below the levels that are diagnostic of diabetes[47]. Patients with IGT and IFG have a significant risk of developing diabetes mellitus and thus are an important target group for primary prevention.

Compared with normoglycaemic persons, patients with IGT and IFG are also at substantially greater risk of developing cardiovascular disease[48] and are frequently associated with Metabolic Syndrome[49]. The natural history of IGT is well documented. In a 10 year follow-up study 15% of people with IGT subsequently developed type 2 diabetes mellitus, while 22% remained glucose intolerance[50]. Increasing age was an independent risk factor for developing diabetes. Patients with transient IGT tend to revert to normal within about 6 months, but they remain at increased long term risk of developing type 2 diabetes mellitus [50]. There are no clear biochemical markers that predict those at particular risk of progression to diabetes.

The progression from normal glucose tolerance to type 2 DM is characterized by insulin resistance and/or beta cell dysfunction[46]. Insulin resistance is characterized by decreased tissue sensitivity to insulin and compensatory hyperinsulinaemia. Initially, plasma glucose levels are maintained in the normal range. In patients who will eventually develop diabetes, there is a decline in beta cell secretory capacity. The first glucose abnormality that is detected is a rise in the post prandial glucose levels because of the reduced first phase insulin secretion. With time, further decline in beta cell function leads to elevation of the fasting glucose levels. Eventually, diabetes occurs with more insulin secretory loss[51].

Major diabetes prevention trials including Diabetes Prevention Program, Finnish Diabetes Prevention Study and Da Quing IGT and Diabetes study have demonstrated the success of lifestyle modification in delaying or preventing the development of diabetes[52].

CHAPTER THREE

3. MATERIALS AND METHOD

3.1 STUDY AREA

The study was carried out in Sokoto state of Nigeria. Sokoto state is located in Northwest Nigeria within the savannah zone between longitudes 11˚ 30″ to 13˚ 50″ East and latitude 4˚ to 6˚ North. It is bordered in the north by Niger Republic, Zamfara state to the east and Kebbi state to the south and west. The warmest months are between February and April when day time temperatures are over 40^0C. The rainy season is from June to October. It has a population of 3,696,999 people according to figures of the 2006 National population Census.

The inhabitants are predominantly Muslims of Hausa and Fulani ethnic background.

3.2 STUDY DESIGN

The study was a cross-sectional descriptive survey.

3.3 INCLUSION CRITERIA

- Males and females in the age range ≥16 and ≤65 years of age
- Subjects who are Fulani by birth and resident in Sokoto for at least 5 years.
- Willingness to participate by giving their informed consent.

3.4 EXCLUSION CRITERIA

- Subjects less than 16 years or greater than 65 years of age as at last birthday.
- Subjects unwilling to participate.
- Chronic illness – such as heart failure, chronic liver disease and tuberculosis.

3.5 **SAMPLE SIZE**

The sample size was determined using the formula[53] –

$$N = \frac{Z^2 Pq}{d^2}$$

N = The desired sample size

Z = The standard deviation set at 1.96 which correspond to 95 % confidence level.

P = The estimate of prevalence rate from review of literature (50 % for this study, no reasonable estimate)

q = 1- P

d = Degree of accuracy desired set at 5%

$$N = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2}$$

$$= \frac{0.9604}{0.0025}$$

$$= 384$$

However, four hundred subjects were recruited from each of the two research groups to make up for drop outs.

Eight hundred subjects were recruited for the research.

3.6 **ETHICAL CONSIDERATION**

Ethical clearance was obtained from the ethical committee of Usmanu Danfodiyo University Teaching Hospital Sokoto (Appendix I). Individual consent was also sought before being enlisted for the study (Appendix II).

3.7 SELECTION OF SUBJECTS

Urban and rural communities in Sokoto were selected using the multistage sampling method based on the existing administrative divisions. This involved selection in stages until the final sampling units were arrived at.

The first stage sampling units was randomly selected from a list of urban and rural areas in Sokoto state. A list of wards and compounds was made from the first stage. A random sample of these second stage units was then selected. These units were then studied. Gumbi and Wamakko villages of Wamakko Local Government were the selected rural areas, while Mabera and Yar'akija areas were the selected urban areas.

The people that met the inclusion criteria were instructed to present at a designated survey site for the screening.

3.8 MATERIALS AND EQUIPMENT

3.8.1 **Materials and supplies**

1. Non-stretch metric tapes.
2. Glucometer strips (One Touch Test Strips Basic Lifescan, Canada.)
3. Fluoride oxalate bottles.
4. Universal bottles.
5. Methylated spirit and cotton wool.
6. Syringes(5ml and 10ml) with 21G needles.
7. Disposable gloves.
8. Insulin ELISA kits (DSL-10-1600 ACTIVE® - Diagnostic Systems Inc. Texas, USA).
9. Lipids kits (Biolabo S.A France)
10. Glucose oxidase reagent (Boerhinger Mannheim, Germany).

3.8.2 Equipment

1. Electronic weighing balance (Contech Instruments Ltd, India)
2. Portable stadiometers (Surgifriend medicals, England).

3. Glucometer (One Touch Basic LifeScan, Canada)
4. Digital automatic blood pressure monitor (OMRON)
5. Littman's stethoscopes (Cardiff, UK).
6. Centrifuge (IEC Model K, Needham Massachusetts).
7. Spectrophotometer (Milton Roy Company Spectronic 20D)
8. Refrigerator.
9. ELISA Plate Reader (BIO-TEK Instruments, England)

3.9 STUDY PROCEDURE

Ten research assistants made of medical doctors and medical students who understand English and Hausa/Fulani (languages spoken in the state) were utilized to assist in data collection. Two laboratory technologists were also utilized to assist in sample collection.

Permission and cooperation for the study was obtained from the village and ward heads.

The research procedure was based on modification of WHO STEPS instrument (Appendix II).[54] The WHO STEPwise approach to surveillance (STEPS) is the WHO recommended surveillance tool for chronic diseases risk factors and chronic disease-specific morbidity and mortality. STEPS is a sequential process that starts with gathering key information on risk factors with a questionnaire, then to simple physical measurements and then to more complex collection of blood samples for biochemical analysis. It covers three different levels or 'Steps' of risk factor assessment: Step 1, Step 2 and Step 3 as follows:

STEP 1: Gathering demographic and behavioral information by questionnaire in a household setting.

STEP 2: Collecting physical measurements with simple tests.

STEP 3 Taking blood samples for biochemical measurement.

3.9.1 LIFESTYLE

STEP 1 involved administering a pre-tested questionnaire (Appendix III) by a trained research assistant. Information about demographic characteristics, lifestyle, diet and family history of diabetes mellitus was obtained.

3.9.2 PHYSICAL MEASUREMENTS

Physical measurements were carried out using modification of WHO STEP 2 (Appendix IV).

Weight Measurement– The weight was measured with an electronic weighing scale without shoes and with the patient in light cloth, to the nearest 0.1kg.

Height Measurement– The height was measured with a stadiometer to the nearest 0.1 centimeter.

Waist Circumference Measurement– With the aid of a non stretch tape, the waist circumference was taken midway between the inferior margin of the last rib and the iliac crest in a horizontal plane to the nearest 0.1cm at the end of normal expiration.

Hip Circumference Measurement– It was measured at the level of the greater trochanters with the subjects wearing light clothing to the nearest 0.1cm.

Blood Pressure Measurement - The procedure was guided by the operating manual of the Digital Automatic Blood Pressure Monitor

The details of the procedures is as in WHO STEPS 2 instrument in Appendix IV

3.9.3 **BIOCHEMICAL PROCEDURES**

Biochemical measurements were done using a modification of WHO STEP 3 guideline, and included fasting plasma glucose, oral glucose tolerance test, fasting lipids, and fasting plasma insulin.

The oral glucose tolerance test (OGTT), fasting insulin and fasting lipids were conducted in 100 randomly selected subjects (50 from each location).

Oral Glucose Tolerance Test

The pattern of glucose tolerance was determined using the OGTT. The OGTT was done according to WHO guideline (Appendix V). The subjects fasted 8-14 hours prior to testing. Fasting venous blood was collected from the subject's forearm into fluoride oxalate bottle. 75 grams oral anhydrous glucose dissolved in 250 ml of water was administered to subjects, and another sample taken 2 hours later.

Insulin Resistance

Fasting plasma insulin estimation was determined using enzyme linked immunoabsorbent assay (ELISA) (Appendix VI). Insulin resistance was determined by HOMA-IR[55] according to the formula below:

$$\text{HOMA-IR} = \frac{\text{fasting plasma insulin } (\mu\text{iU/ml}) \times \text{fasting plasma glucose (mmol/L)}}{22.5}$$

Plasma Glucose Assay

The plasma glucose estimation was done in one hundred subjects using Trinder's analytic method (Appendix VII)[56]. This was used to determine the pattern of glucose tolerance.

Estimation of Serum Lipids

Serum total cholesterol, HDL-cholesterol and Triglyceride was determined using commercial kit by Biolabo S.A France(Appendix VIII).

TOTAL CHOLESTEROL- Serum total cholesterol was determined by the cholesterol esterase/cholesterol oxidase technique.

HDL CHOLESTEROL- The VLDL and LDL-cholesterol content of the serum was precipitated by a phosphotungistic acid and magnesium ion complex before the HDL- cholesterol content was determined in the supernatant.

TRIGYCERIDE- Triglyceride was determined by enzymatic colorimetric test (Appendix VIII).

LDL CHOLESTEROL- LDL-cholesterol was calculated using the Friedewald formula[57]:

$$\text{LDL-Cholesterol} = \text{Total cholesterol} - \text{HDLC} - \frac{\text{Triglyceride}}{2.2} \quad \text{mmo/l}$$

Fasting Capillary Blood

Fasting and casual capillary glucose was also measured using glucometer in 373 and 309 subjects respectively. Instant medical advice was given to the subjects with diabetes mellitus and impaired fasting glucose.

Plasma Separation and Storage

Blood samples were centrifuged at 2,500 revolutions/min and the plasma separated. The samples for insulin and lipids estimation were then stored in the refrigerator at -20^{0}c until the time of analysis.

3.9 STATISTICAL ANALYSIS

Raw data were entered into a spread sheet (Microsoft Excel 2003). Statistical analysis was performed using Microsoft Excel and Epi-Info version 3.3.2. Significance of differences between group means was assessed using Student's t – test while Chi square test was employed to determine significance of results of comparison of proportions between groups. Linear relationships were determined using Pearson's correlation coefficients. The level of statistical significance is set at $p \leq 0.05$.

3.11 DEFINITION OF TERMS

1. Diabetes mellitus- Fasting plasma glucose >126 mg/dl (7.0 mmol/l) or two hour post-glucose load >200mg/dl (11.1 mmol/l) plus symptoms of diabetes[1].

2. Impaired glucose tolerance- Normal fasting plasma glucose with 2 hour post-glucose load >140 mg/dl (7.8mmol/l) but less than 200 mg/dl (11.1 mmol/l) .[1]

3. Impaired fasting glycaemia- Fasting plasma glucose >110 mg/dl (6.1 mmol/l) but less than 126 mg/dl (7.0 mmol/l).[1]

4. BMI calculated as [weight (kg)]/[height (metre)^2)[58] is categorised as:

Underweight – Body Mass Index < 18.5kg/m^2

Normal – Body Mass Index 18.5kg/m^2 – 24.9kg/m^2

Overweight – Body Mass Index >25kg/m^2 but <29.9kg/m^2

Obesity – Body Mass Index >30kg/m^2

5. Central Obesity as defined by IDF[61]

- Waist circumference ≥ 94cm (men)
- Waist circumference ≥ 80cm (women)

Central obesity as defined by WHO[49]

- Waist circumference >88cm (women)
- Waist circumference >102cm (men)

6. Hypertension- Blood pressure measurement above 140/90mmHg and/or those on antihypertensives (Appendix IX) [59].

7. Inadequate fruits and vegetable – intake of less than 10 servings in a typical day (1 serving= 1 medium size banana, orange Or ½ cup Chopped,

cooked, canned fruit or 1 cup of raw green leafy vegetables

Or ½ cup other vegetables)[54].

8. Sedentary lifestyle – walk of less than thirty minutes per day.
9. Urban area- an area that is highly populated with increased density of human-created structures in comparison to areas surrounding it[60].
10. Rural area- Sparsely settled places away from the influence of large cities. Generally characterized by farms, ranches, and small town[60]
11. Metabolic Syndrome: This is defined using the IDF criteria[61]
    a. presence of central obesity (waist circumference ≥94 cm in men, ≥80cm in women) plus 2 of the following
    b. raised blood pressure (BP≥130/85mmhg)
    c. Raised fasting plasma glucose ≥ 100mg %
    d. Raised triglyceride level >150mg/dl
    e. Reduced HDL cholesterol level (<40mg/dl in males, <50mg/dl in females).
12. Insulin resistance -

(i) HOMA-IR – Insulin resistance - values above 95% confidence limit of

subjects with normal plasma glucose.

(ii) Fasting plasma insulin - values above 95% confidence limit of subjects

with normal plasma glucose.

CHAPTER 4

RESULTS

4.1 Analysis of the Quality of Research Data

4.2 Socio-demographic characteristics of the subjects

4.3 Anthropometric characteristics of subjects

4.4 Glucose tolerance studies

4.5 Risk factors for type 2 diabetes mellitus

4.6 Values and pattern of Lipidaemia

4.7 Blood pressure values and prevalence of hypertension

4.8 Analysis of Components and frequency of Metabolic syndrome

4.9 Effect of lifestyle on glucose intolerance

4.10 Analysis of results of Insulin resistance Studies

RESULTS

4.0 ANALYSIS OF THE QUALITY OF RESEARCH DATA

4.1.1 Response rate

Of the 800 subjects recruited into the study, 782 subjects [376(48.1%) females and 406(51.9%) males] completed the study, giving a response rate of 97.7%. There was no significant difference between the proportions of males and females ($p>0.05$)

4.1.2 PRECISION STUDIES OF GLUCOSE AND INSULIN ASSAYS

4.1.2.1 Plasma glucose assay

The performance of the plasma glucose and insulin assays using the intra-assay and inter-assay coefficients of variation of the tests are shown in Table 3 and Table 4 respectively.

Table 3 Performance of plasma glucose assay

Assay	*Glucose level	Number of samples	Mean	SD	CV%
Intra-assay	Low	10	5.29	0.06	1.2

	High	10	15.37	0.27	1.8
Inter assay	Low	20	5.16	0.17	3.2
	High	20	15.27	0.42	2.7

SD= standard deviation, CV= coefficient of variation, *Plasma glucose level in mmol/l.

CV% = (SD/Mean) x 100

Table 4 Performance of plasma insulin assay

Assay	FPI level	Number of samples	Mean	SD	CV%
Intra-assay	sample A	10	2.18	0.096	4.4
	sample B	10	4.43	0.095	2.2
Inter assay	sample A	10	2	0.81	4
	sample B	10	4.28	0.13	3

FPI=fasting plasma insulin in μU/ml, SD= standard deviation, CV= coefficient of variation.

CV% = (SD/Mean) x 100

Both assays yielded low CV% which were within the acceptable limits of variation.

4.2 SOCIODEMOGRAPHIC CHARACTERISTICS

4.2.1 Age of participants

Figure 1 shows distribution of participants by age and location.

There was no significant difference in the distribution by age between rural and urban participants ($X^2 = 0.77$, $P = 0.94$)

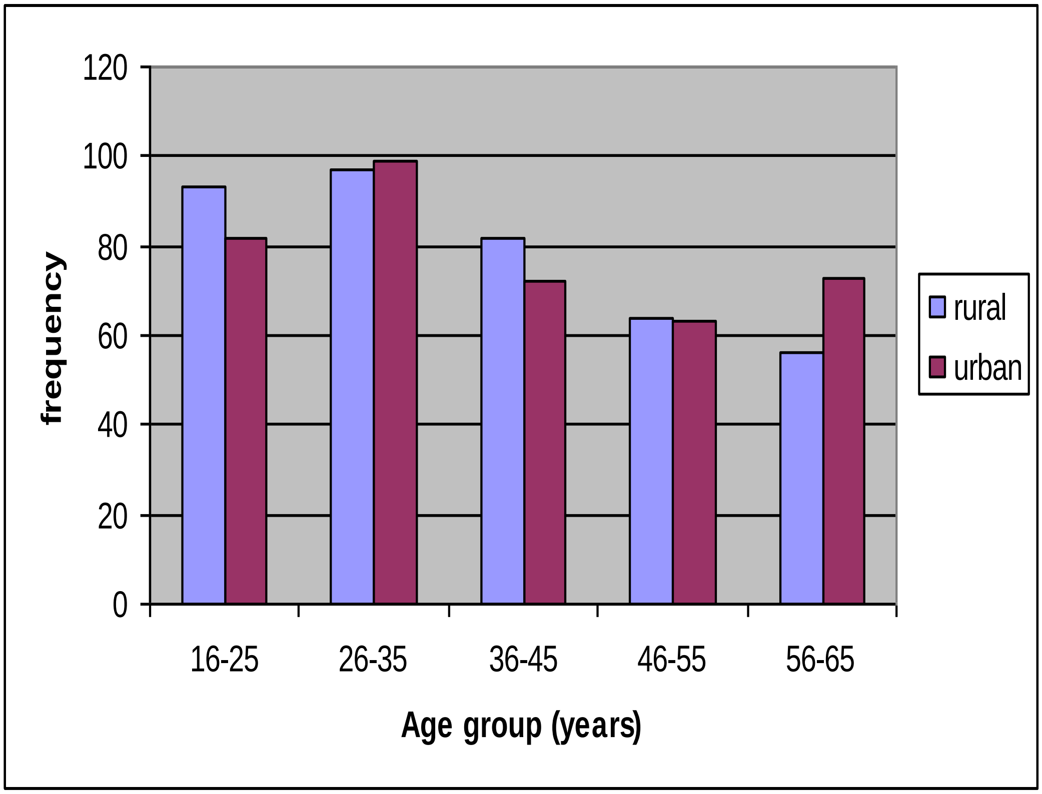

Figure 1 Distribution of participants by age group and location

The mean (SD) age of the rural subjects was 38.5(13.6) years and that of the urban was 39.4(14.2) years. There was no significant difference in the means of ages of the urban and rural subjects (p= 0.45).

The mean ages of the females in the rural and urban subjects were 36.6(13) years and 36.4(14.1) years respectively, while that of males in rural and urban subjects were 40.3(13.9) years and 42.1(13.7) years respectively (p=0.173).

4.2.2 Educational level

Table 5 compares the distribution of participants by educational level and location.

Table 5 Distribution of participants by educational level and location

Educational level	Number (%)					
	Rural			**Urban**		
	Overall	Male	Female	Overall	Male	Female
None	28(7.1)	5(1.3)	23(5.9)	8(2.1)	8(2.1)	0(0)
Koranic	263(66.9)	118(30)	145(36.9)	125(32.1)	37(9.5)	88(22.6)
Primary	33(8.4)	22(5.6)	11(2.8)	42(10.8)	32(8.2)	10(25.7)
Secondary	45(11.5)	41(10.4)	4(1)	55(14.1)	28(7.2)	27(6.9)
Tertiary	24(6.1)	24(6.1)	0(0)	159(40.9)	94(24.2)	65(16.9)
Total	393(100)	210(53.4)	183(46.6)	389(100)	199(51.2)	190(48.8

Two hundred and ninety six (74%) of the rural subjects had only basic education while two hundred and fourteen (55%) of the urban subjects had secondary and tertiary education.

The urban subjects had significantly higher levels of education than the rural subjects (X^2=41.1, p=0.000).

4.2.3 Occupational Status of Participants

The distribution of participants by occupation and location is shown in Table 6.

Most (71%) of the rural subjects had unskilled jobs while significantly higher number of the urban subjects (39.4%) were professionals (p=0.003).

Table 6 Distribution of participants by Occupation and location

Occupation	**Number (%)**					
	Rural			**Urban**		
	Overall	Male	Female	Overall	Male	Female
Unemployed	75(26.8)	15(3.8)	60(15.3)	103(26.5)	25(6.4)	78(20.1)
Unskilled	280(71.2)	166(42.2)	114(29)	96(24.7)	54(13.9)	42(10.8)
Professional	19(4.8)	17(4.3)	2(0.5)	153(39.3)	103(26.5)	50(12.9)
Others	19(4.8)	13(3.3)	4(1)	37(9.5)	16(4.1)	21(5.4)
Total	393(100)	210(53.4)	183(46.6)	389(100)	199(51.2)	190(48.8)

4.3 ANTHROPOMETRIC CHARACTERISTICS

4.3.1Anthropometric characteristics of all study subjects

The anthropometric characteristics of study subjects are as shown in Table 7. The Table compares the anthropometric features across locations and sex.

Table 7 Anthropometric characteristics of the study subjects by location

Variable	Mean (SD)		p value
	Rural (n=393){M=210,F=183}	**Urban** (n=389){M=199,F=190}	
Weight (kg)			
All	58.5(9.7)	65.9(12.9)	<0.001
Males	60.8(9.3)*	68.8(12.6)*	<0.001
Females	55.8(9.6)	62.8(12.5)	<0.001
Height(cm)			
All	163.0(8.0)	165.5(8.1)	0.001
Males	166.6(7.1)*	170.3(6.5)*	0.001
Females	158.9(7.1)	160.4(6.4)	0.037
Body Mass Index (kg/m^2)			
All	21.9(3.1)	24.02(4.2)	0.001
Males	21.9(2.9)	23.7(4)	0.007
Females	22.1(3.3)	24.4(4.4)	<0.001
Waist circumference (cm)			
All	78.6(8.7)	84.3(10.6)	<0.001
Males	79.2(8.7)	85.5(10.3)*	0.001
Females	77.9(8.6)	82.9(10.7)	0.001
Waist Hip ratio			
All	0.86(0.06)	0.87(0.07)	0.199
Males	0.87(0.06)*	0.89(0.06)*	0.001
Females	0.85(0.06)	0.84(0.07)	0.322

Data are expressed as means ± SD. M= male; F= female, *=significant difference between males and females.

The urban subjects were significantly heavier [65.9 vs. 58.5 kg ($p<0.001$)] and had higher BMI [24 vs. 21.9 kg/m^2 ($p<0.001$)] than the rural subjects. The male subjects were significantly heavier than the female subjects in both urban and rural settings (p=<0.001).

The mean WHR of the urban subjects was higher than the mean WHR of the rural subjects but not statistically significant (p=0.199).

The mean waist circumference of the urban subjects was significantly higher than the mean waist circumference of the rural subjects ($p<0.001$). Elevated waist circumference for females was described as values above 95% confidence limit of the female subjects (83cm), while elevated waist circumference for males was described as values above 95% confidence limit of the male subjects (85 cm). One hundred and twenty nine (34.6%) females and 143 (34.9%) males had elevated waist circumference.

4.3.2 Anthropometric characteristics of participants by age groups

Table 8 compares the weight, body mass index and waist circumference values of the participants when subdivided into young adults (<40 years), middle age (41-60 years) and elderly adults (>60 years).

Table 8 Anthropometric characteristics of participants by age groups

Type of adult	Mean (SD) Rural	Urban	P value
Weight (kg)			
Young	58.4(9.3)	62.5(10.9)	<0.001
Middle age	59.3(10.3)	70.7(13.9)	0.002
Elderly	56.7(9.9)	67.0(12.6)	<0.001
Body Mass Index (kg/m^2)			
Young	21.9(2.8)	23.1(3.7)	0.004
Middle age	22.2(3.7)	25.2(4.4)	<0.001
Elderly	21.7(3.2)	24.8(4.4)	<0.001
Waist circumference (cm)			
Young	76.9(7.6)	80.5(9.1)	<0.001
Middle age	80.8(9.3)	88.4(10.2)	<0.001
Elderly	80.4(9.8)	88.6(11)	<0.001

Young ≤40years, Middle age>40<60years, Elderly≥60 years

In all adult categories, the urban subjects had significantly higher mean weight, BMI and WC values than the rural subjects. These anthropometric indices also peaked in middle age and declined in the elderly in both sex and location settings.

4.4 GLUCOSE TOLERANCE STUDIES

4.4.1 Fasting plasma glucose

The means of fasting plasma glucose for all 423 subjects and the sexes are shown in Table 9.

Table 9 Mean fasting plasma glucose in rural and urban subjects

	Mean (SD) FPG (mmol/l)		P – value
	Rural	Urban	
All	5.02(0.59)	5.37(1.8)	0.009
Females	4.9(0.57)	5.25(1.9)	0.090
Males	5.11(0.60)	5.49(1.7)	0.036
P – value	0.032	0.328	

FPG= fasting plasma glucose

While the urban subjects in general and the males in particular had higher FPG values than their rural counterparts, the difference in the female values was not significant even though the trend was similar.

The mean FPG was higher in the males than the female subjects but not statistically significant (p= 0.118). The mean FPG was significantly higher in the rural males than the rural females (p= 0.032), however there was no statistical difference between the males and females in the urban location (p=0.328).

4.4.2 Pattern of Fasting plasma glucose by location and gender

Four hundred and twenty three subjects had fasting plasma glucose estimation. The pattern of fasting plasma glucose in these subjects is as shown in Table 10.

Table 10- Pattern of Fasting plasma glucose by location and gender

Category	Overall	Number (%)					
		Rural (n=204)			Urban (n=219)		
		All	Male	Female	All	Female	Male
Normal	353(83.4)	178(87.3)	96(47.1)	82(40.2)	175(79.9)	93(42.5)	82(37.4)
IFG	63 (14.9)	26(12.7)	9(4.4)	17(8.3)	37(16.9)	17(7.8)	20(9.1)
DM	7 (1.7)	0	0	0	7(3.2)	3(1.4)	4(1.8)
Total	423 (100)	204	105	99	219	113	106

IFG=Impaired fasting glycaemia; DM=diabetes mellitus

Overall 353 (83.4%) of the study subjects had normoglycaemia comprising 178 (50.4%) and 175 (49.6%) rural and urban subjects respectively. Sixty three study subjects had impaired fasting glycaemia making the overall prevalence of IFG 14.9%. The prevalence is significantly higher in urban (16.9%) than in rural (12.7%) locations (p = 0.002). No significant difference in the gender (p = 0.22). Seven subjects (1.7%) had plasma glucose in the diabetic range. All the subjects with DM were from the urban area.

Overall, 44(22.4%) males had dysglycaemia (IFG +DM) compared to 29 (13.3%) females (X^2=2.7, p=0.101).

4.4.3 Oral glucose tolerance test

The mean values of two hour post-glucose load plasma glucose level of 98 study subjects are as shown in Table 11.

Table 11 Mean values at two hour post glucose load by location and sex

	Mean (SD) 2hr PGL mmol/l		P value
	Rural	Urban	
All	6.3(1)	6.5(1.6)	0.450

Females	6.2(1.1)	6.2(1)	0.831
Males	6.5(1)	6.9(2)	0.390
P value	0.211	0.551	

PGL= post glucose load (mmol/l)

All the group of urban subjects had higher plasma post glucose load than the rural subjects but not statistically significant (p= 0.45). The urban males had higher mean post glucose load than the urban females but not statistically significant (0.551). The rural males had higher mean post glucose load than the rural females but not statistically significant (0.211).

4.4.4 Oral Glucose Tolerance Test by location and gender

The pattern glucose tolerance of 98 study subjects using OGTT is as shown in Table 12.

Table 12 pattern of glucose tolerance using OGTT by sex and location

GT Category	Overall	Number (%)					
		Rural (n=50)			Urban (n=48)		
		All	Male	Female	All	Male	Female
Normal	85(86.7%)	45(90)	22(44)	23(46)	40(83.3)	23(47.9)	17(35.4)

IGT	12(12.2%)	5(10)	2(4)	3(6)	7(14.6)	3(6.3)	4(8.3)
DM	1 (1%)	0(0)	0(0)	0(0)	1(2.1)	0(0)	1(2.1)

GT= glucose tolerance, IGT=impaired glucose tolerance; DM=diabetes mellitus

Of the 98 subjects that had OGTT 85(86.7%) had normal plasma glucose. Overall 12 subjects (12.2%) had impaired glucose tolerance comprising 7 (14.6%) and 5(10%) from the urban and rural locations respectively (X^2=0.02, p=0.889). The only DM (1%) was from the urban group.

4.4.5 Casual plasma glucose

The mean casual plasma glucose values in 359 study subjects are as shown in Table 13.

Table 13 Mean values of CPG by location and sex

	Mean (SD) CPG		P
	Rural	Urban	
All	6.77(1.57)	7.27(2.8)	0.044
Females	6.65(1.64)	7.19(2.77)	0.140
Males	6.85(1.52)	7.33(2.9)	0.152
P value	0.456	0.753	

CPG= Casual plasma glucose in mmol/l

The overall mean casual plasma glucose is significantly higher in the urban than rural locations (p= 0.044).There was no significant difference in mean casual plasma glucose in the males and females in both urban and rural locations.

4.4.6 Distribution of study subjects by Casual plasma glucose status

Three fifty nine subjects had casual plasma glucose estimation.

The pattern glucose tolerance using CPG is as shown in figure 2.

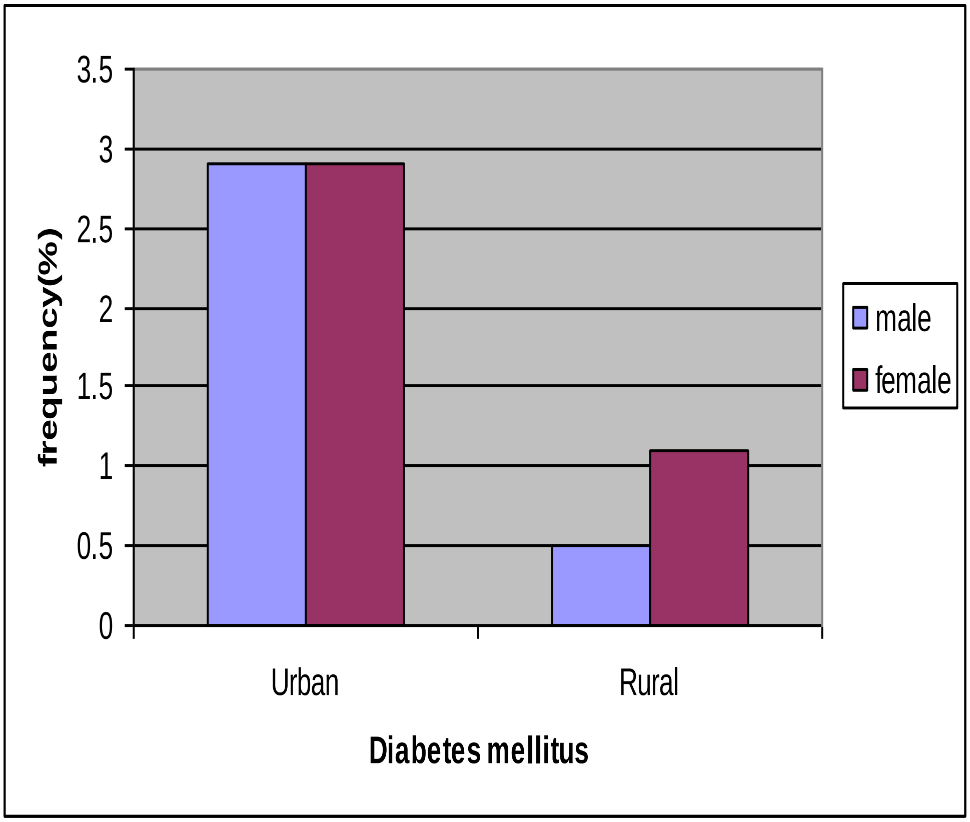

Figure 2 -Pattern of glucose tolerance using casual plasma glucose

Thirteen subjects (3.6%) had CPG in the diabetic range. Three (1.6%) subjects were from the rural subjects and ten (5.9%) were from the urban subjects ($p<0.001$). There was no significant difference in gender distribution ($X^2=1.65$, $p=0.198$)

4.4.6 OVERALL GLYCAEMIC STATUS

The overall glycaemic status of the study subjects using fasting plasma glucose, post-glucose load plasma glucose and casual plasma glucose are summarised in table 14.

The prevalence of undiagnosed diabetes mellitus was 2.7%. The prevalence was significantly higher in urban (4.6%) than in rural (0.8%) location (p=0.0001). The prevalence rates in males (2.8%) and females (2.6%) were not significantly different ($p<0.05$). The overall prevalence of IFG was 14.9% significantly higher in urban (16.9%) than in rural (12.7%) locations ($p = 0.002$). The prevalence of IFG was also higher in males (18%) than in females (11.9%) p=0.101.

TABLE 14 Overall glycaemic status by location and sex

Dysglycaemic group	**Number (%)**					
	Rural			**Urban**		
	All	Female	Male	All	Female	Male
Impaired fasting glycaemia	26(12.7)	9(4.4)	17(8.3)	37(16.9)	17(7.8)	20(9.1)
Impaired glucose tolerance	5(10)	2(4)	3(6)	7(14.6)	3(6.3)	4(8.4)
Diabetes mellitus	3 (0.8)	2(0.5)	1(0.3)	18(4.6)	8(2.1)	10(2.6)
	X^2= 5.1	P=0.024				

4.5 RISK FACTORS FOR TYPE 2 DIABETES MELLITUS

4.5.1 Distribution of study subjects by risk factors for diabetes mellitus

The distribution of study subjects by risk factors for type 2 diabetes mellitus is summarised in Table 15.

Table 15. Risk factors for type 2 diabetes mellitus

Risk factor	Number (%)						P value
	Rural			Urban			
	All	Females	Males	All	Females	Males	
Central obesity (IDF)	77(19.6)	64(16.2)	13(3.3)	141(36.2)	113(29)	28(7.2)	0.720
Central obesity (WHO)	21(5.4)	19(4.8)	2(0.5)	61(15.7)	50(12.9)	11(2.8)	0.617
Obesity(BMI)	8(2)	7(1.9)	1(0.3)	26(6.7)	15(3.9)	11(2.8)	0.003
overweight	51(13)	19(4.8)	32(8.2)	122(31.4)	72(18.5)	50(12.9)	0.001
Family history	0(0)	0(0)	0(0)	31(8)	23(5.9)	8(2.1)	0.001
Cigarette smoking	38(9.7)	0(0)	38(9.7)	44(11.3)	0(0)	44(11.3)	0.676
Alcohol intake	1(0.3)	0(0)	1(0.3)	4(1)	0(0)	4(1)	0.001
Physical inactivity	135(34.4)	85(21.7)	50(12.8)	207(53.2)	120(30.8)	87(22.4)	0.670
Inadequate diet	175(44.6)	86(21.9)	89(22.7)	141(36.2)	65(16.7)	76(19.5)	0.060

WC=waist circumference, BMI=body mass index, IDF=international diabetes federation, WHO= World Health Organization.

Obesity, family history of diabetes mellitus and alcohol intake were commoner in the urban than rural subjects.

Obesity

The mean (SD) waist circumference of the urban subjects 84.3(10.6) cm was significantly higher than that of rural subjects 78.6(8.7) cm $p<0.001$.

The mean (SD) BMI of the urban subjects 24.0(4.2) kg/m^2 was significantly higher than that of rural subjects 21.9(3.1) kg/m^2 p=0.001.

Lifestyle-related risk factors

***Cigarette Smoking*.** Eighty- two (10.5%) subjects had history of cigarette smoking. There was no significant difference between urban and the rural subjects, $p>0.05$. All the subjects were males.

Alcohol intake. Only five (0.6%) subjects admitted to a history of alcohol ingestion. Four (1%) were from the urban subjects and one (0.3%) from the rural subjects. All the subjects were males.

Physical inactivity. Three hundred and forty-two (43.7%) subjects were physically inactive comprising of 207(53.2%) and 135(39.5%) from the urban and rural locations respectively.

***Diet*.** Three hundred and sixteen (40.4%) subjects had inadequate intake of fruits and vegetables, an attribute that was more common in the rural group but there was no significant difference between rural 175(55.3%) and urban 141(34.4%) subjects p=0.06.

Family history of diabetes mellitus

Thirty-one (3.9%) subjects had a family history of diabetes mellitus, of whom were all from the urban subjects. No detected DM subject admitted to having a family history of diabetes mellitus.

4.5.2 AGE AS A RISK FACTOR FOR DIABETES MELLITUS

The prevalence of diabetes mellitus by age group is shown in figure 3.

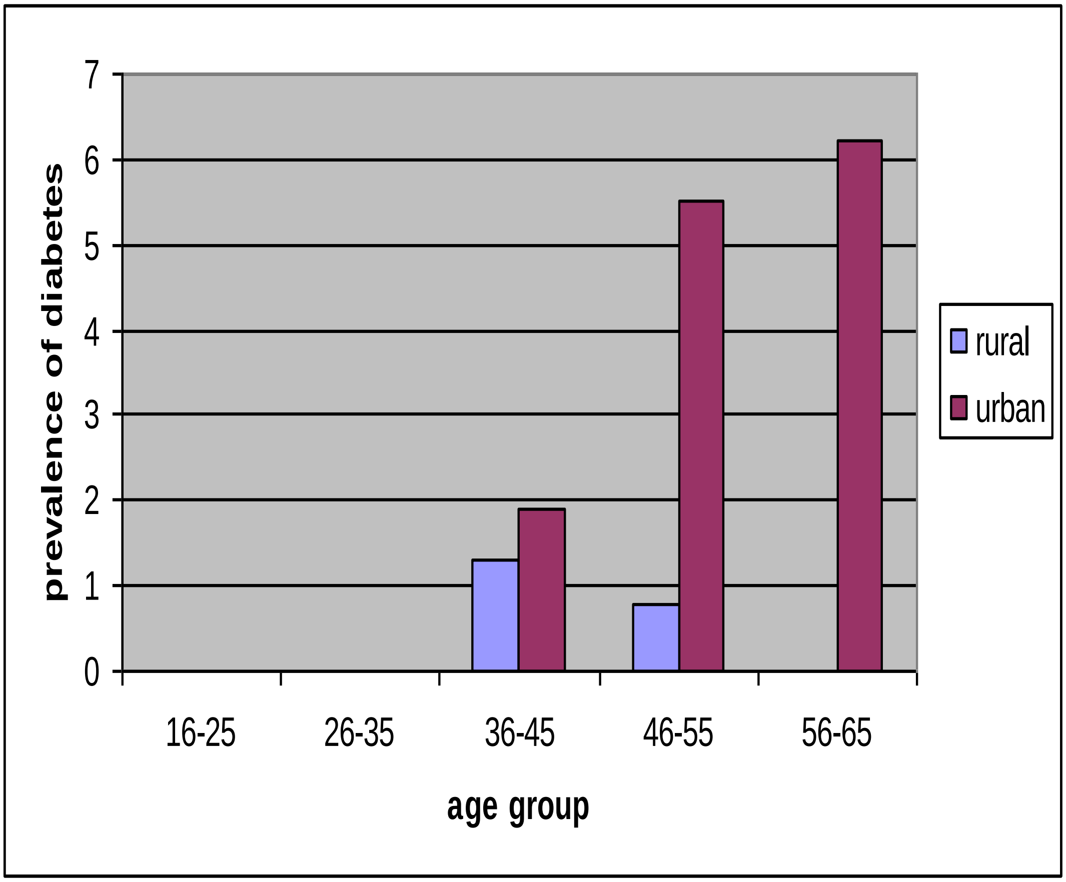

Figure 3 Prevalence of diabetes by age group

The prevalence of diabetes mellitus increased with age. There was no detected case of diabetes mellitus in subjects below 36 years of age. The mean (SD) age of subjects with dysglycaemia [49.7(11.3) years] was significantly higher than that of subjects with normoglycaemia [37.9 (13.7) years] ($p<0.001$).

4.6 VALUES AND PATTERN OF LIPIDAEMIA

4.6.1 Average Values of Plasma lipids

The values of major lipids in rural and urban study subjects are compared in Table 16.

Table 16 Values of major lipids in rural and urban study subjects

Lipid	Mean (SD) mg/dl						P
	Rural			Urban			
	All	Males	Females	All	Males	Females	
TC	148.28 (24.35)	145.65 (23.9)	151.12 (25.02)	175.91 (49.6)	183.75 (62)	168.69 (34.2)	<0.001
HDLC	51.14 (7.93)	49.62 (5.79)	52.78 (9.6)	50.22 (11.8)	47.12 (10.6)	53.08 (12.2)	0.640
LDLC	89.62 (25.58)	87.53 (20.65)	91.87 (30.33)	104.22 (50.96)	110.78 (63.67)	98.16 (35.78)	0.071
TG	104.48 (36.39)	103.02 (36.64)	106.06 (36.85)	109.07 (41.83)	112.16 (46.03)	106.21 (38.25)	0.560

TC= total cholesterol, HDLC=high density lipoprotein cholesterol, LDL=low density lipoprotein cholesterol, TG=triglyceride

The urban subjects had lower values of HDLC than the rural subjects but not statistically significant (p=0.640). The urban subjects had higher total cholesterol, LDLC and triglycerides than the rural subjects.

4.6.2 Pattern of lipidaemia by location

The pattern of lipidaemia by location is as shown in Table 17.

Table 17 Pattern of lipidaemia in Rural and Urban Fulani

Dyslipidaemia	Number (%)		
	All n=100	Urban n=50	Rural n=50
None	74(74)	32 (64)	42 (82)
Increased TC	8(8)	7 (14)	1 (2)
Decreased HDL	17(17)	11 (22)	6 (12)
Increased TG	13(13)	9 (18)	4 (8)
Increased LDL	6(6)	4 (8)	2 (2)
		$X^2 = 19.6$	$P<0.001$

Increased TC = Total cholesterol >200mg/dl, Decreased HDL= HDL cholesterol<40mg/dl in males or <50mg/dl in females, Increased TG = Triglyceride >150mg/dl, Increased LDL= LDL> 150mg/dl [(61)]

The urban subjects had significant higher occurrence of dyslipidaemia than the rural subjects (p<0.001). The most frequent dyslipidaemia was decreased HDL cholesterol (17%) which was more common in the urban group. The least frequent dyslipidaemia was increased LDL cholesterol (6%).

4.6.3 Frequency of dyslipidaemia by sex

The frequency of dyslipidaemia by sex is as shown in Table 18.

Table 18 Frequency of dyslipidaemia by sex

Dyslipidaemia	Number (%)		
	All (100)	Female(50)	Male (50)
None	74(74)	37(74)	37(74)
1	13(13)	6(12)	7(14)
2	9(9)	5(10)	4(8)
3	2(2)	2(4)	0(0)
4	2(2)	0(0)	2(4)
		X^2=1.81	P=0.178

1=frequency of 1 dyslipidaemia, 2= frequency of 2 dyslipidaemia, 3=frequency of 3 dyslipidaemia, 4= frequency of 4 dyslipidaemia

Multiple dyslipidaemia was not very common as only about 4% of the subjects had more than 2 dyslipidaemia. There was no significant difference in the frequency of dyslipidaemia between the males and the females (p=0.178). The frequency of one lipid abnormality was higher than other lipid abnormalities (13%).

4.7 BLOOD PRESSURE

4.7.1 Blood pressure by location

The mean (SD) systolic and diastolic blood pressures are as shown in Table 19.

Table 19 Blood pressure by location

Gender	Mean (SD) mm Hg		P value
	Rural	Urban	
Systolic Blood Pressure			
All	126(13.01)	128.16(15.51)	0.226
Males	127.72(11.91)	130.66(14.67)	0.002
Females	128.39(14.05)	125.53(13.52)	0.050
Diastolic Blood Pressure			
All	77.98(9.70)	78.64 (10.57)	0.364
Males	76.0(9.4)	81.78(9.76)	<0.001
Females	80.25(9.62)	75.35(10.4)	<0.001

The overall mean systolic and diastolic blood pressures were higher in the urban than the rural subjects but were not statistically significant. The mean systolic and diastolic blood pressures were significantly higher in the urban males than the rural males ($p<0.05$) but the reverse was the case in the females. The mean systolic and diastolic blood pressures were higher in the rural females than the urban females ($p<0.05$).

4.7.2 HYPERTENSION

The distribution of hypertension by location is shown in table 20.

Table 20 Distribution of subjects with hypertension by location

Gender	Number (%)	
	Rural	Urban
All	17(4.3)	39(10)
Males	7(1.8)	26(6.7)
Females	10(2.5)	13(3.3)
	$X^2=1.37$	$p=0.510$

The frequency of hypertension was higher in the urban than the rural subjects but not statistically significant (p=0.510). There was no significant gender difference (p=0.263).

4.8 METABOLIC SYNDROME

4.8.1 **Determinants of metabolic syndrome**

The determinants of metabolic syndrome are as shown in table 21.

Table 21 Determinants of Metabolic Syndrome by Location

Determinant	Number (%)							P value
		Rural			Urban			
	Total	All	Males	Females	All	Males	Females	
↑WC(IDF)	229 (29.3)	82 (35.8)	13 (5.6)	69 (30.1)	147 (64.2)	28 (12.2)	119 (52)	0.790
↑WC (WHO)	82 (10.5)	21 (5.4)	2 (0.5)	19 (4.8)	61 (15.7)	11 2.8)	50 (12.9)	0.19
Hypertension	56 (7.2)	17 (4.3)	7 (1.8))	10 (2.5)	39 (10)	26 (6.7)	13 (3.3)	0.510
Dysglycaemia	83 (10.6)	29 (34.9)	18 (21.7)	11 (13.4)	55 (65.1)	30 (36.1)	25 (30.1)	0.385

↑TG	13 (13)	4 (30.7)	3 (23.1)	1 (7.7)	9 (69.2)	6 (46.2)	3 (23.1)	0.451
↓HDL	17 (17)	6 (35.3)	2 (11.8)	4 (23.5)	11 (64.7)	7 (41.2)	4 (23.5)	0.004

↑WC= increased waist circumference, ↑plasma glucose= increased plasma glucose, ↑TG== increased triglycerides, ↓HDL= decreased high density lipoprotein, IDF=international diabetes federation, WHO=World Health Organization.

Increased waist circumference, blood pressure, plasma glucose, HDL and triglycerides were commoner in the urban than the rural subjects.

4.8.2 Distribution of Metabolic Syndrome

The distribution of metabolic syndrome using the international diabetes federation (IDF) criteria is as shown in Table 22.

Table 22 Metabolic syndrome by location

Gender	Number (%)		
	Total	Rural	Urban
All	37(4.7)	6(1.5)	31(8)
Males	18(2.3)	2(0.5)	16(4.1)
Females	19(2.4)	4(1)	15(3.9)
	X^2=7.39	p=0.007	

The prevalence of metabolic syndrome was higher in urban population (8%) than the rural population (1.5%) p=0.007. There was no significant difference between the males and females (p=0.85).

4.9 LIFESTYLE INDICES AND GLUCOSE TOLERANCE

The relationships between lifestyle indices and glucose tolerance are summarized in Table 23.

Table 23 Relationships lifestyle indices and fasting glucose tolerance.

Variable	Glucose tolerance status [Number (%)]				
	Total	Normal	IFG	DM	All DG
Cigarette smoking					
Smokers	82	63(76.8)	15(18.3)	4(4.9)	19(23.1)*
Nonsmokers	700	636(90.9)	48(6.9)	16(2.3)	64(9.2)

Physical activity					
Active	439	396(90.2)	32(7.3)	11(2.5)	43(9.8)
Inactive	342	302(88.3)	31(9.1)	9(2.6)	40(11.7)
Diet					
Adequate f/v	462	416(90)	34(7.4)	12(2.6)	46(10)
Inadequate f/v	320	283(88.4)	29(9.1)	8(2.5)	37(11.6)

IFG=impaired fasting glycaemia, DM=diabetes mellitus, DG=dysglycaemia (IFG+DM), f/v=fruits/vegetables, *= p<0.05 (statistically significant).

Cigarette smoking. Out of 82 subjects that smoked cigarette 63 (75.6%) had normal plasma glucose, 15 (19.5%) impaired glucose tolerance and 4 (4.9%) had diabetes mellitus. The frequency of cigarette smoking in diabetes mellitus subjects was 19%. The frequency of cigarette smoking in IFG subjects was 23.8%.

Physical inactivity. Out of the 342 subjects that were physically inactive 302 (88.3%) had normal plasma glucose, 31 (9.1%) had IFG and 9 (2.6%) had diabetes mellitus. The frequency of physical inactivity in diabetes mellitus subjects was 42.8%. The frequency of physically inactivity in IFG subjects was 49.2%.

Diet. Out of the 320 subjects that had inadequate intake of fruits and vegetables 283(88.4%) had normal plasma glucose, 29(9.1%) had IFG and 8(2.5%) had diabetes mellitus. The frequency of inadequate intake of fruits and vegetables in diabetes mellitus subjects was 38.1%. The frequency of adequate intake of fruits and vegetables in IFG subjects was 46 %.

4.10 INSULIN RESISTANCE

4.10.1 Clinical characteristics of subjects studied for insulin resistance and non-insulin resistance study subjects

The clinical characteristics of subjects studied for insulin resistance and those not chosen for insulin resistance study subjects are as shown in table 24.

Table 24 Clinical characteristics of subjects studied for IR & nonIR

Variable	Mean (SD)		P value
	IR study subjects	Non IR study subjects	
Age (years)			
All	39.9(13.4)	38.9(13.8)	0.52
Females	37.2(12.5)	36.5(13.9)	0.74

Males	42.6(14.7)	41.2(13.8)	0.48
Weight (kg)			
All	62.1(13.4)	62.2(11.8)	0.933
Females	58.3(11.3)	59.6(11.7)	0.469
Males	65.9(14.3)	64.6(11.3)	0.440
Body Mass Index (kg/m^2)			
All	22.9(3.8)	23(3.8)	0.74
Females	22.9(3.6)	23.3(4)	0.55
Males	22.8	22.7(3.8)	0.88
Waist circumference (cm)			
All	81.5(10.6)	81.5(9.9)	0.99
Females	80.3(10.3)	80.6(9.9)	0.84
Males	82.7(11)	82.4(9.8)	0.82

Data expressed as means (SD). Weight in kilograms; Height in centimeters; BMI= body mass index; WC= waist circumference in centimeters; *=significant difference between males and females.

There was no significant difference between the clinical characteristics of subjects studied for insulin resistance and other subjects. Therefore this study group is a good representation of the study population.

4.10.3 FASTING PLASMA INSULIN

The mean (SD) fasting plasma insulin levels are as shown in Table 25.

Table 25. Mean fasting plasma insulin by location and sex

Gender	Mean (SD) FPI in μU/ml	P value

	Total	Rural	Urban	
All	13.2(13.6)	10.35(10.29)	16.13(15.97)	0.041
Females	8.5(7.3)	7.15(6.72)	9.81(7.78)	0.230
Males	17.5(16.4)	13.17(12.1)	22.18(19.4)	0.057
P value	0.001	0.044	0.008	

FPI=fasting plasma insulin

The mean fasting plasma insulin levels were significantly higher in the urban than the rural subjects (p=0.041). The mean fasting plasma insulin levels were also significantly higher in the males than the females (p=0.001).

4.10.4 Values of Homeostasis Model Assessment of insulin resistance (HOMA-IR) in study subjects.

The mean (SD) HOMA-IR values are shown in table 26.

Table 26 HOMA-IR by location and sex

Gender	Mean (SD)	P value

	Total	Rural	Urban	
All	3.67(4)	2.32(2.59)	4.22(5.0)	0.024
Females	1.95(1.7)	1.54(1.36)	2.35(1.93)	0.116
Males	4.44(5.1)	3.01(3.2)	6.02(6.30)	0.042
P	0.003	0.052	0.0126	

Homeostasis Model Assessment of insulin resistance
HOMA-IR= **(**FPG in (mmol/L) x fasting plasma insulin in μU/ml)/ 22.5

The overall mean HOMA-IR level was significantly higher in the urban than the rural subjects (p=0.024), the levels were also higher in both sexes but not statistically significant. Comparing the sexes in both locations, the mean HOMA-IR levels were higher in the males in both urban and rural groups. The overall mean HOMA-IR levels were significantly higher in the males than the female subjects (p=0.003).

4.10.5 Clinical characteristics of subjects evaluated for HOMA-IR

Table 27. **Comparison of Clinical characteristics insulin sensitive and insulin resistant subjects.**

Variable	Insulin	Insulin	P value

	sensitive Mean (SD)	resistance Mean (SD)	
Number	77	23	
Age	37.3(13.6)	48.3(11.3)	<0.001*
BMI	22.2(3.4)	25.2(4.4)	<0.001*
WC	79.8(9.8)	87.2(11.5)	<0.003*
WHR	0.85(0.1)	0.89(0.1)	0.016*
SBP	126.5(12.7)	142.7(19.2)	<0.001*
DBP	78.3(10.6)	85.2(12.8)	0.010*

Data expressed as means (SD). BMI= body mass index; WC= waist circumference in centimeters; WHC=waist to hip ratio, SBP=systolic blood pressure in mmHg, DBP=diastolic blood pressure in mmHg, * p <0.05 statistically significant.

Using mean ± 1.96SEM, which is HOMA-IR of 2.44-3.98 at 95% confidence interval in subjects with normal plasma glucose to define normal insulin sensitivity, insulin resistance was defined as HOMA-IR >3.98.

Insulin resistant subjects were older, had higher BMI, WC, WHR, SBP and DBP than insulin sensitive subjects. All these parameters were of statistical significance (see table 27).

4.10.7 Pattern of insulin resistance

The pattern of insulin resistance as determined by HOMA-IR in urban and rural study subjects is shown in figure 4.

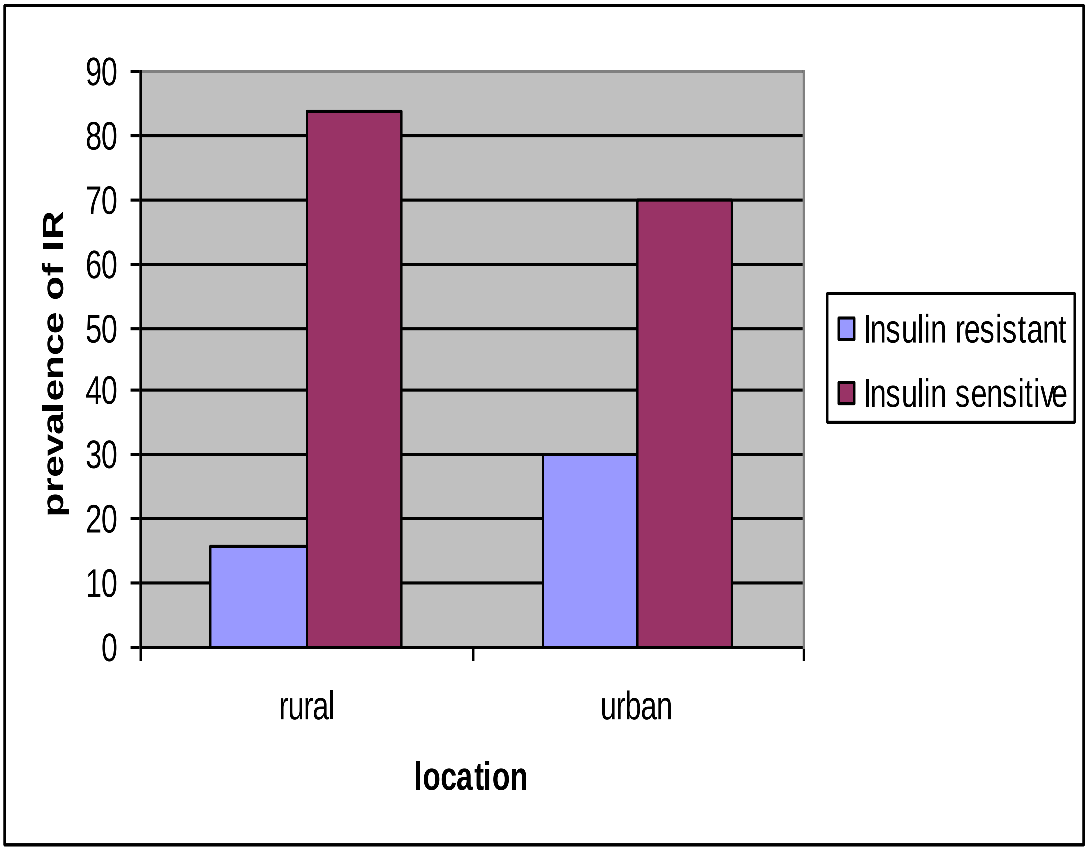

Figure 4 Insulin Resistance by location

One hundred subjects had HOMA-IR estimation of which 23 % were insulin resistant. The prevalence was higher in the urban subjects (30%) than the rural subjects (16%) p= 0.435. The prevalence was higher in the males (28%) than the females (18%) but not statistically significant (p=1.99).

4.8.8 Prevalence of insulin resistance by HOMA-IR and fasting plasma insulin

The prevalence rates of insulin resistance by HOMA-IR and fasting plasma insulin are compared in figure 5.

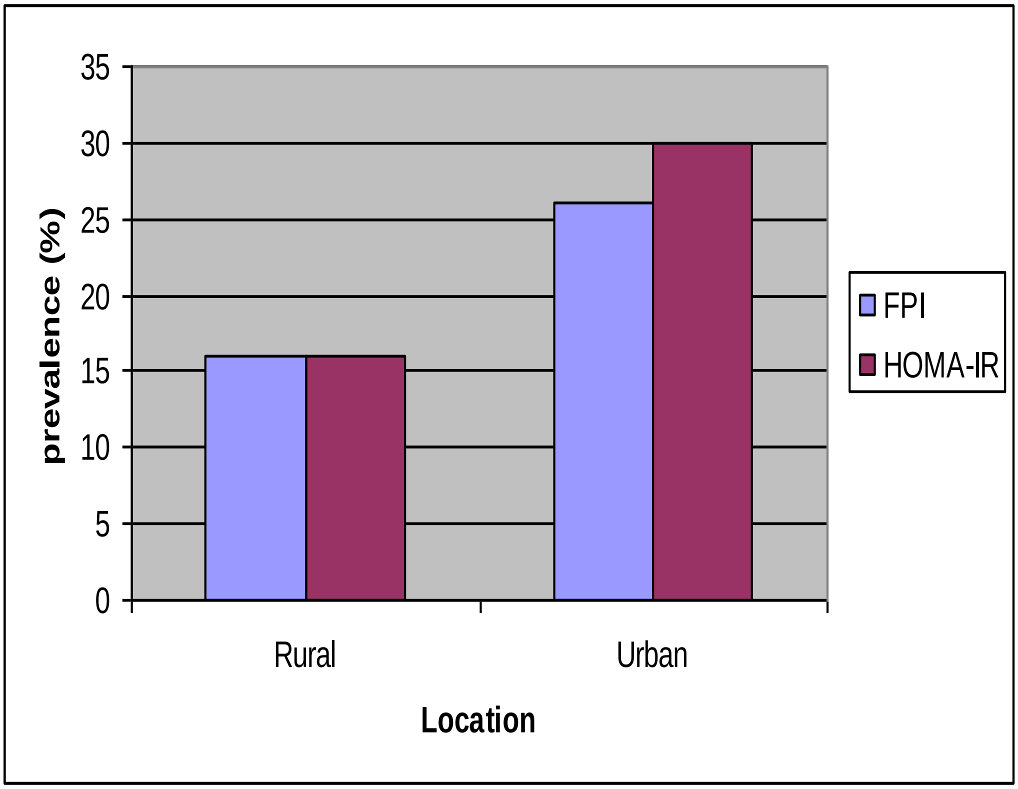

Figure 5 Insulin resistance by HOMA-IR and fasting plasma insulin (FPI)

Normal FPI was determined as mean ± 1.96SEM at 95% confidence interval in subjects with normal plasma glucose (7.7-19.7μU/ml). Insulin resistance was defined as FPI > 19.7μU/ml.

The prevalence of insulin resistance using fasting plasma insulin was 25% which was similar to that obtained using HOMA-IR of 23%. There was no significant difference in the prevalence of insulin resistance using HOMA-IR and FPI (p=0.75)

4.10.9 Correlation matrix of the indices of insulin resistance

The relationship between HOMA-IR and clinical variables is as shown in table 28.

Table 28 Correlation matrix of the indices of insulin resistance

Correlation coefficient (r)

	Age	**WC**	**BMI**	**SBP**	**DBP**	**FPI**	**HOMA-IR**
Age	1.000	0.410*	0.134	0.405*	0.490*	0.260†	0.580*
WC	0.410*	1.000	0.701*	0.340*	0.323*	0.141†	0.230*
BMI	0.134	0.701*	1.000	0.330*	0.227†	0.179†	0.490*
SBP	0.405*	0.340*	0.330*	1.000	0.970*	0.166*	0.290*
DBP	0.490*	0.323*	0.227†	0.970*	1.000	0.040	0.081
FPI	0.260†	0.141†	0.179†	0.166*	0.040	1.000	0.970*
HOMA-IR	0.580*	0.230*	0.490*	0.290*	0.081	0.970*	1.000

BMI= body mass index; WC= waist circumference in centimeters, SBP=systolic blood pressure, DBP=diastolic blood pressure, HOMA-IR=Homeostasis Model Assessment of insulin resistance, FPI=fasting plasma insulin**,** †=significant difference $p<0.05$
*=significant difference $p<0.01$,

There was significant positive relationship between HOMA-IR and age, body mass index, waist circumference, systolic blood pressure and fasting plasma insulin. The correlation was highest between HOMA-IR and fasting plasma insulin ($r=0.970$, $p< 0.001$).

CHAPTER 5

DISCUSSION

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

Developing countries are known to be entering the epidemiological transition with the burden of cardiovascular diseases and type 2 diabetes mellitus increasing as the population is ageing. Urbanization appears to be associated with extreme changes in dietary habits, psychological stress, and physical inactivity. There is a large variability in the occurrence of type 2 diabetes mellitus (DM), even within the same racial and ethnic group. This may be accounted for by differences in environmental factors such as physical inactivity, obesity, diet, stress and urbanization[5]. This study represents a survey of the rural as well as the urban population of the north-western part of Nigeria using the modification of the WHO STEPwise approach to surveillance (STEPS). The WHO STEPwise approach to surveillance (STEPS) is the WHO recommended surveillance tool for chronic diseases risk factors and chronic disease-specific morbidity and mortality.

5.2 PATTERN OF GLUCOSE TOLERANCE

The study found overall prevalence of type 2 Diabetes Mellitus in adults in Sokoto to be 2.7% with urban and rural populations having prevalence rates of 4.6% and 0.8% respectively. The prevalence of impaired fasting glycaemia was 14.9%. It was significantly higher in urban (16.9%) than in rural (12.7%) locations (p = 0.002).

5.2.1 Prevalence of diabetes mellitus

The prevalence of diabetes mellitus found in this study is higher than the National prevalence of 2.2% with highest prevalence in urban community of Lagos mainland (7.2%) and lowest prevalence of diabetes mellitus in rural community of Mangu, Plateau state (0.6%)[10]. The prevalence of 4.6% in the urban population is higher than that (1.5% and 1.9% in males and females respectively) obtained in a survey of Lagos metropolis by Ohwovoriole et al[11]. The prevalence is also higher than that obtained by Puepet who found prevalence of

3.1% in urban Jos[12]. The increased prevalence may be due to modernization as is observed in other studies[5]. The increased prevalence may also be due to ethnic reason, as study by Nyenwe[62] at Port Harcourt reported higher prevalence of Diabetes Mellitus among Ibibio and Hausa Fulani than other tribes. The prevalence

is however lower than the prevalence in Port Harcourt (7.9%) which is a more industrialized city than Sokoto[62].

The low prevalence of diabetes mellitus in rural community is in keeping with other works that show traditional rural communities still have low prevalence of diabetes mellitus[41]. Bakari et al found the prevalence of 1.6% in a suburban Northern Nigerian city and Erasmus et al found a prevalence of 1.4% in a rural population of Kwara state (1.4%)[13,63].

This study found higher prevalence of type 2 diabetes mellitus in urban community than the rural community which has been observed in other studies[40,64]. The study on Pima Indians found much higher prevalence of diabetes mellitus in urbanized US Pima Indians (38%) than the traditional Mexican Pima Indians (6.9%)[40]. Hussain et al[64] found a higher prevalence of diabetes mellitus in urban (8.1%)

compared with rural populations (2.3%) in Bangladesh. The low prevalence of diabetes mellitus in the rural community could be attributed to the more traditional lifestyle which depends on animal husbandry and subsistence economy. The high prevalence of diabetes mellitus in the urban community could be attributed to modernization with adoption western lifestyle.

5.2.2 Prevalence of Impaired fasting glycaemia/Impaired glucose tolerance

The prevalence of impaired fasting glycaemia and impaired glucose tolerance were also higher in urban than in rural locations in keeping with other studies[40,64.] However Ramachandra[65] in India found no significant urban-rural difference in the prevalence of impaired glucose tolerance (8.7% and 7.8% respectively).

The 12.2% prevalence of IGT found in this is similar to the study of Sesikawa et al[66] that found prevalence of IGT to be 12% in Japan and Ajlouni et al[67] who found prevalence of 9.8% in Jordan. However the prevalence was lower than 24.3% found by Chen et al[68] in Taiwan which could be as a result of rapid urbanization of Taiwan. A large population-based screening study in Australia by Dunstan et al[69] found an overall prevalence of diabetes of 7.4%, and identified an additional 16.4% of the population with impaired glucose tolerance. Williams et al[70] found 16.7% prevalence of impaired glucose tolerance in the UK. The prevalence was higher than 7.6% found by Omar et al in South Africa[71].

5.3 RISK FACTORS FOR DIABETES MELLITUS

5.3.1 AGE AND DIABETES MELLITUS

Increasing age is a known risk factor for development of type 2 diabetes mellitus. The prevalence of diabetes mellitus and impaired fasting glycaemia in both urban and rural locations increased with age in this study. No subject with diabetes mellitus was below 35 years of age in this study. This is in keeping with the report of the national survey on non-communicable diseases in Nigeria which found a significant rise in prevalence of diabetes mellitus with age (r=0.934, p<0.001)[10]. Similar findings were obtained in other studies[72]. In the U.S.A, Harris et al[72] found 1.4% prevalence of diabetes mellitus in age category 20-39 years but 17.3% in age category 60-74 years.

5.3.2 OBESITY

Obesity is one of the most important modifiable risk factors in the aetiology of type 2 diabetes mellitus[14,15]. Obesity occurred more commonly in the urban than the rural communities. Differences in obesity may be related to differences in energy intake and expenditure. The mean (SD) waist circumference of the urban subjects 84.3(10.6) cm was significantly higher than that of rural subjects 78.6(8.7) cm p=0.000.The mean (SD) BMI of the urban subjects 24.0 (4.2) kg/m^2 was significantly higher than that of rural subjects 21.9(3.1) kg/m^2 p=0.001. This is similar to other studies[40,73]. Benjamin et al[73] found significantly higher prevalence of obesity in the urban than the rural populations of Guatemala. The study by Leslie et al[40] on Pima Indians found prevalence of obesity in the traditional Mexican Pima Indians to be much lower than in the U.S. Pima Indians**.** Obesity was 10 times more frequent in U.S. Pima men and 3 times more frequent in the women than in their Mexican Pima counterparts.

Obesity is also commoner in the female subjects compared to the male subjects. This is similar to the findings of Bakari[13] and Akintewe[74] in a suburban Northern Nigerian community and Western Nigeria respectively. The higher occurrence in females may be due to cultural practices in which physical activity is restricted to household chores, and women are not traditionally involved in sporting activities. This study has also shown that central obesity is more common (35.3%) than the global obesity (23.5%) and therefore particular emphasis should be placed on the detection and management of central obesity.

5.3.3 PHYSICAL INACTIVITY

The risk of type 2 diabetes mellitus is decreased with increasing amount of exercise[22,23]. The findings from this study show prevalence of physical inactivity to be higher in urban than in rural populations. This may be due to the fact that rural Fulani mostly live a subsistence economy where they farm and rear cattle. Much of their physical activity is occupational in nature and related to providing food and subsistence to their families. In contrast, the urban Fulani have adopted Western lifestyle with low level of occupational physical activity. The findings are similar to Sobngwi et al[75] in Cameroon that found significantly lower physical activity (P<0.001), light occupation, and reduced walking and cycling time in urban compared to rural subjects. Study by Benjamin et al[73] also found rural subjects had a higher physical activity level than urban subjects in Guatemala. Most rural subjects (73%) had a physically moderate or heavy lifestyle, and only 14% had very light activity. The reverse was seen among urban dwellers.

5.3.4 FAMILY HISTORY OF DIABETES MELLITUS

Type 2 diabetes mellitus is known to cluster in families. Studies by Erasmus et al[76] found type 2 diabetes mellitus to be heritable in black South African diabetics. In this study all the subjects that gave family history of diabetes mellitus were from the urban population. This may be because of higher prevalence of diabetes mellitus in the urban subjects than the rural subjects. The literacy level is also higher in the urban than the rural subjects and therefore awareness of family history is expected to be higher in the urban subjects. However, conclusions can not be made from this study as diabetes mellitus may be asymptomatic and many subjects don't go for routine check-up and hence family history may go undetected.

5.3.5 CIGARETTE SMOKING AND DIABETES MELLITUS

Cigarette smoking is an independent modifiable risk factor for type 2 diabetes mellitus[27]. In this study there was no significant difference between cigarette smoking in the urban and rural subjects. Cigarette smoking did not appear to be an associated risk factor for diabetes mellitus in this study.

5.3.6 DIET AND DIABETES MELLITUS

There was no significant difference between intake of fruits and vegetables between the urban and rural subjects. Inadequate fruits and vegetable intake did not appear to be an associated risk factor for diabetes mellitus in this study. This finding is similar to that of Danish et al[77] that found the eating routines of the rural population were similar to that of the urban population in Pakistan.

5.4 PREVALENCE OF METABOLIC SYNDROME

The prevalence of metabolic syndrome was found to be 4.7% out of which the urban (8%) had significantly higher metabolic syndrome than the rural (1.5%) p=0.007. Similar urban-rural difference was found by Xiaoping et al[78] in China in which the prevalence of the metabolic syndrome was significantly higher for urban than rural subjects (12.7 vs. 1.7%, P <0.05). Sarkar et al[79] also found significantly higher prevalence of metabolic syndrome in the urban than the rural subjects (37% vs. 4%, p<0.05)

in India.

Other studies however found higher prevalence of metabolic syndrome than this study[80,81]. Hanan et al[81] found the prevalence of metabolic syndrome (17%) in West Bank to be much higher than the findings of this study without significant urban-rural difference ($p<0.05$). Gupta et al[82] found the prevalence of metabolic syndrome in an Indian urban population to be 31.6%. The high prevalence of metabolic syndrome in these studies could be as a result of much rapid urbanization of these populations. The lower prevalence of metabolic syndrome in this study may be because not all components of metabolic syndrome were determined in all subjects and hence some subjects with metabolic syndrome were probably not detected.

The components of metabolic syndrome were significantly higher in the urban than the rural population as was found in similar studies[78,83,]. Pongchaiyakul et al[83] demonstrated a significant difference in urban versus rural lipid levels and the prevalence of dyslipidemia in Thailand. Benjamin et al[73] also found the mean serum lipid concentrations were significantly higher in the urban than the rural populations of Guatemalan adults. This may be as a result of consumption fatty diets in the urban than the rural populations. The cow milk that is obtained from the rural location is rather sold and serves as a source of income to the family.

The prevalence of hypertension was higher in the urban (10%) than rural (4.3%) locations as was found in other studies[84]. Seedat et al[84] found prevalence of hypertension to be significantly higher in the urban (25%) than the rural population among the Zulu of South Africa. The higher prevalence of hypertension in the urban population may be due to stress and lifestyle associated with urbanization. However, some studies did not show significant difference between urban and rural populations[73].

5.5 PREVALENCE OF INSULIN RESISTANCE

In this study 23% of the subjects evaluated for insulin resistance using HOMA-IR were insulin resistant. The prevalence of insulin resistance was 25% when fasting plasma insulin was used. There was statistically significant correlation between HOMA-IR and fasting plasma insulin ($p<0.01$, $r = 0.970$) in this study as was also found by Hettihawa et al[85] in Sri Lanka that compared insulin resistance by indirect methods and found fasting insulin had a statistically significant correlation with HOMA indices ($p <0.01$, $r = 0.906$). The present study also demonstrated that the HOMA cutoff point for diagnosis of insulin resistance was 3.98 which is similar to the findings by Reinehr et al[86], Marques-Vidal et al[80], and Mehmet et al[87] that defined Insulin resistance as a HOMA values greater than 4, 3.8 and 3.16 respectively. The prevalence of insulin resistance is similar to Bakari et al[88] who found 27.8% of control subjects had insulin resistance. Reaven[89] reported 25% of normal Europeans are insulin resistant. The insulin resistance was higher in the urban than the rural subjects. Similar difference was also found in the prevalence of diabetes mellitus between the urban and the rural subjects.

This study also found correlation between insulin resistance and anthropometric indices. Other studies also found positive correlation between insulin resistance using HOMA-IR and anthropometric indices[90,91]. The positive correlation between increased age and insulin resistance is similar to the findings of Marques-Vidal et al[80] that found increased prevalence of insulin resistance with age in both sexes.

5.6 LIMITATIONS

1. The study was carried out in the adults only therefore the true prevalence of diabetes mellitus and glucose intolerance was not obtained for the whole community.
2. The gold standard for investigating and quantifying insulin resistance the hyperinsulinemic euglycemic clamp was not used because it is a cumbersome procedure therefore not suitable for large-scale population studies.
3. Oral glucose tolerance test which is the ideal WHO criteria for confirmation of diabetes mellitus was done for only ninety eight subjects because of the cumbersome nature of the test and large sample size.

4. Fasting plasma glucose could not be done to all subjects because they took their meals very early before the arrival of the research team.

5.7 CONCLUSIONS

1. The prevalence of diabetes mellitus in the Fulani’s of North western Nigeria was higher than the previous national prevalence indicating increasing prevalence of diabetes mellitus in Nigeria.
2. The prevalence of diabetes mellitus and impaired fasting glycaemia were higher in the urban Fulani than the rural Fulani.
3. The risk factors for mellitus were higher in the urban community than the rural community.
4. The major risk factors for diabetes mellitus and glucose intolerance from this study were increased age and obesity.

5. The prevalence of insulin resistance was high in the Fulani's of North western Nigeria.
6. The prevalence of insulin resistance was higher in the urban community than the rural community.
7. There were positive correlations between Insulin resistance and anthropometric indices.

5.8 RECOMMENDATIONS

1. There is need for prospective follow up studies in the glucose intolerant subjects and insulin resistant subjects in order to monitor for the development of diabetes mellitus.
2. Further studies should involve children particularly in urban areas in order to have exact prevalence of diabetes mellitus and glucose intolerance.

3. The results underline the need to increase public screening and to emphasize the value of lifestyle modification toward traditional African lifestyle.

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5.1 APPENDIX II

<u>INFORMED CONSENT</u>

Research study: Glucose Tolerance among Rural and Urban Fulanis

This is to certify that I

____ have been fully informed about the study and have accepted to participate. My refusal to further participate in this study at any stage will not in any way affect my regular management.

I understand that the study is to be carried out solely for the purpose of medical research and I am willing to act as a volunteer for that purpose.

Signature/thumb print …………………… Date…………………………

I _____________________________ have explained the nature of the study and the risk involved. All information will be strictly confidential.

Signature…………………. ……………………

Date…………………………

5.2 APPENDIX III

WHO STEPS INSTRUMENT

The WHO STEPwise approach to surveillance (STEPS) is the WHO recommended surveillance tool for chronic diseases risk factors and chronic disease-specific morbidity and mortality. It provides an entry point for low and middle income countries to get started on chronic diseases surveillance activities. It is also designed to help countries build and strengthen their capacity to conduct surveillance.

STEPS is a sequential process. It starts with gathering key information on risk factors with a questionnaire, then to simple physical measurements and then to more complex collection of blood samples for biochemical analysis. STEPS emphasizes that small amount of good quality data are more valuable than large amount of poor data. It is based on the following two key premises:

• Collection of standardized data, and

• Flexibility for use in a variety of country situations and settings.

STEPS use a representative sample of the study population. This allows for results to be generalized to the population.

The STEPS tool used to collect data and measure chronic disease risk factors is called the STEPS Instrument.

The STEPS Instrument covers three different levels or 'Steps' of risk factor assessment: Step 1, Step 2 and Step 3 as follows:

STEP 1: Gathering demographic and behavioral information by questionnaire in a household setting. To obtain core data on sociodemographic information, tobacco and alcohol use, nutritional status and Physical activity.

STEP 2: Collecting physical measurements with simple tests in a household setting.

To build on the core data in Step 1 and determine the proportion of adults that is overweight/obese, and has raised blood pressure.

STEP 3 Taking blood samples for biochemical measurement. To measure prevalence of diabetes and abnormal blood lipids. Only recommended for well resourced settings.

Within each Step, there are three levels of data collection- the core, expanded and optional levels These depend on what can realistically be accomplished (financially, logistically and in terms of human and clinical resources) in each country setting.

Source: (Ref.54)

5.3 APPENDIX IV

STUDY PROTOCOL (Modification of WHO STEPS**)**

IDENTIFICATION NUMBER………...... DATE…………………..

BIODATA:

1. NAME ……………………………………………………………....
2. AGE ……………………….. DATE OF BIRTH ……………….
3. SEX- male………..

   female…………
4. OCCUPATION
   a. unemployed
   b. Petty trading
   c. Farmer
   d. Unskilled labour
   e. Cattle rarer
   f. Clerk /Typist
   g. Professional
   h. Others…………….
5. HIGHEST EDUCATIONAL LEVEL ATTAINED
   a. None
   b. koranic
   c. Primary school
   d. Secondary school

e. tertiary

6. MARITAL STATUS-

a. single

b. married

c. widow/widower

d. divorced

SMOKING

7. Do you smoke cigarette? Yes No

8. If yes, how many sticks of cigarette do you smoke per day? ....

9. How long have you been smoking cigarette? ………………………..

ALCOHOL

10. Do you consume alcohol? Yes No

11. What type of alcohol do you consume? a. beer b. wine c. spirit
d. palmwine e. locally fermented drinks

12. How many bottles do you consume per day? ………………………..

13. How long have you been drinking alcohol? …………………………..

DIET

14. How many days do you eat fruit per week? …………………………..

15. How many servings of fruit do you eat on one of those days? ……….

1 Serving = 1 medium size banana, orange Or ½ cup Chopped, cooked, canned fruit

16. In a typical week, on how many days do you eat vegetables?
....

17. How many servings of vegetables do you eat on one of those days?

1 Serving = 1 cup of raw green leafy vegetables (Spinach, salad) Or ½ cup other vegetables,
cooked or chopped raw (Tomatoes, carrots, pumpkin, corn, cabbage, fresh beans, onion).

18. Do you add salt to your meals? Yes No
19. What type of oil or fat is most often used for meal preparation in your household?
    Vegetable oil …. Butter….. Margarine….. Other….. None used…..

PHYSICAL ACTIVITY

20. Does your work involve vigorous-intensity activity that causes large increase in breathing or heart rate like *[carrying or lifting heavy loads, digging or construction work*] for at least 10 minutes continuously?
    Yes…….. No………………...
21. In a typical week, on how many days do you do vigorous-intensity activities as part of your work? 0….. 1…….. 2….. 3…….. 4…… 5…….. 6…… 7…………
22. How much time do you spend doing vigorous-intensity activities at work on a typical day? Hours…… minutes……
23. Do you walk or use a bicycle for at least 10minutes continuously to get to and from places? Yes No
24. How much time do you spend walking per day?
    Hours…… minutes……
25. Do you do any vigorous-intensity sport, fitness or recreational activities (running or football) for at least 10 minutes continuously? Yes No
26. In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational activities? 0… 1… 2… 3… 4… 5… 6… 7…
27. How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day? Hours…… minutes…….

MEDICAL HISTORY

28. Have you ever been told by a doctor or other health worker that you have diabetes? Yes No
29. Are you currently receiving any treatment for diabetes prescribed by a doctor or other health worker as well as any advice? Yes No
30. Are you currently taking any herbal or traditional remedy for your diabetes?

    Yes No
31. Does any member of your family have diabetes? Yes No
32. If yes, what is your relationship? a. father b. mother c. sister d. brother

    e. Others (specify)……….
33. Have you been told by a doctor or other health worker that you have raised blood pressure or hypertension? Yes No
34. Are you currently receiving any treatment for raised blood pressure prescribed by a doctor or other health worker as well as any advice?

    Yes No
35. Are you currently taking any herbal or traditional remedy for your raised blood pressure? Yes No
36. Does any member of your family have hypertension? Yes No
37. If yes, what is your relationship? a. father b. mother c. sister d. brother

    e. Others (specify)……….

PHYSICAL MEASUREMENTS

38. Height in Centimetres …………………………………………………………
39. Weight in Kilograms…………………………………………………………...
40. BMI (kg/m^2)……………………………………………………………………
41. Waist circumference in Centimetres………………………………………..
42. Hip circumference in Centimetres ……………………………………………

43. Waist/Hip ratio ………………………………………………………………..

44. Blood pressure - Systolic (mmHg) …… Diastolic (mmHg) ……….

45. Goitre- 0. not palpable or visible

1a. palpable

1b. palpable and visible when neck is extended

2. visible with neck in normal position

3. large goiter visible from distance

BIOCHEMICAL MEASUREMENTS

46. Fasting blood glucose mmol/l

………………………………………………….

47. 2 hours post-glucose load mmol/l

……………………………………………..

48. Fasting Plasma Insulin in (miu/ml)

……………………………………..……

49. Fasting lipids-

a. Total cholesterol----------------

b. HDL-------------------------------

c. LDL--------------------------------

d. Triglycerides --------------------

5.4 APPENDIX V

PROCEDURES FOR PHYSICAL MEASUREMENTS ACCORDING TO MODIFICATION OF WHO'S STEPS INSTRUMENT

HEIGHT MEASUREMENT

Procedure[57]:

1. The participant was asked to remove his/her footwear (shoes, slippers, sandals) and head gear.
2. The participant was asked to stand on a board facing the assistant.
3. The participant was asked to stand with feet together and knees straight
4. The participant was asked to look straight ahead and not look up.
5. The measure arm (horizontal headboard) was moved gently down onto the head of the participant and the participant was asked to breathe in and stand tall.
6. The height in centimetres at the exact point to the nearest 0.1 meter was read.

WEIGHT MEASUREMENT

Procedure[57]:

1. The participant was asked to remove his/her footwear (shoes, slippers, sandals).
2. The participant was then asked to step onto scale with one foot on each side of the scale.
3. The participant was then asked to stand still, face forward, place arms on the side and waited until asked to step off.
4. The weight in kilograms to nearest 0.1kg on the questionnaire was recorded.

MEASUREMENT OF WAIST CIRCUMFERENCE

Procedure[57]:

1. Standing to the side of the participant, the inferior margin

(lowest point) of the last rib and the crest of the ilium (top of the hip bone) was located and marked with a water-based pen.

2. With a non-stretch tape measure, the midpoint was found and marked.
3. The tape was applied over the marked midpoint and the participant was asked to wrap it round himself/herself.
4. The participant was asked to stand with their feet together, placed their arms at their side with the palms of their hands facing inwards, and breathe out gently.
5. The waist circumference was at the level of the tape to the nearest 0.1 cm.
6. The measurement was recorded on the questionnaire.

HIP CIRCUMFERENCE MEASUREMENT

Procedure[57]:

1. Stand to the side of the participant, and ask them to help place the tape around below their hips.
2. Position the measuring tape around the maximum circumference of the buttocks.
3. Ask the participant to stand with their feet together place their arms at their side with the palms of their hands facing inwards, and breathe out gently.
4. Check that the tape position is horizontal all around the body.
5. Measure hip circumference and read the measurement at the level of the tape to the nearest 0.1 cm.

6. Record the measurement on the questionnaire..

BLOOD PRESSURE

The procedure was guided by the operating manual of the Digital Automatic Blood Pressure Monitor[57].

1. The participant was asked to sit quietly and rest for 15 minutes with their legs uncrossed.
2. The right arm of the participant was placed on the table with the palm facing upward.
3. The clothing on the arm was removed.
4. The appropriate cuff size for the participant was used as in table:

Arm Circumference (cms)	**Cuff Size**
17 -22 Select	Small (S)
22-32	Medium (M)
> 32	Large (L)

5. The cuff was positioned above the elbow aligning the mark *ART* on the cuff with the brachial artery.
6. The cuff was wrapped snugly onto the arm and the Velcro securely fasten. **Note:** The lower edge of the cuff was placed 1.2 to 2.5 cm above the inner side of the elbow joint.
7. The level of the cuff was kept at the same level as the heart during measurement.

Three measurements were taken for analysis purposes. The participant rested for three minutes between each of the readings.

8. The mean of the second and third readings was used for analysis

purposes.

5.5 APPENDIX VI

THE ORAL GLUCOSE TOLERANCE TEST

The oral glucose tolerance test (OGTT) is principally used for diagnosis when blood glucose levels are equivocal, during pregnancy, or in epidemiological studies.

The OGTT should be administered in the morning after at least three days of unrestricted diet (greater than 150 g of carbohydrate daily) and usual physical activity. Recent evidence suggests that a reasonable (30–50g) carbohydrate containing meal should be consumed on the evening before the test.

The test should be preceded by an overnight fast of 8–14 hours, during which water may be drunk. Smoking is not permitted during the test. The presence of factors that influence interpretation of the results of the test must be recorded (e.g. medications, inactivity, infection, etc.).After collection of the fasting blood sample, the subject should drink 75 g of anhydrous glucose or 82.5 g of glucose monohydrate (or partial hydrolysates of starch of the equivalent carbohydrate content) in 250–300 ml of water over the course of 5 minutes. Timing of the test is from the beginning of the drink. Blood samples must be collected 2 hours after the test load. Unless the glucose concentration can be determined immediately, the blood sample should be collected in a tube containing sodium fluoride (6 mg per ml whole blood) and immediately centrifuged to separate the plasma; the plasma should be frozen until the glucose concentration can be estimated.

Source: (Ref. 1)

5.6 APPENDIX VII

PLASMA INSULIN ASSAY PROCEDURE:

REAGENTS SUPPLIED

Anti-Insulin-Coated Microtitration wells, Insulin Standards: (Lyophilized),
Insulin Controls: (Lyophilized), Insulin Antibody-Enzyme Conjugate Concentrate,
Assay Buffer B: (GREEN), TMB Chromogen Solution
Wash Concentrate, Stopping Solution

Procedure:

All specimens and reagents were allowed to reach room temperature (~25°C) and mix thoroughly by gentle inversion before use. Standards, Controls and unknowns were assayed in duplicate.

1. The microtitration wells to be used were marked.
2. For the Regular Assay Procedure, pipette 25 μL of the Standards A-E, Controls and unknowns into the appropriate wells. For the Extended Range Assay Procedure, pipette 10 μL of Standards A and C-F, Controls and unknowns into the appropriate wells.
3. The Antibody-Enzyme Conjugate Solution was prepared by diluting the Antibody-Enzyme Conjugate Concentrate in the Assay Buffer as described under the *Preparation of the Reagents* section of this package insert.
4. 100 μL of the Antibody-Enzyme Conjugate Solution was added to each well using a semi-automatic dispenser.

5 The wells were incubated at room temperature (~25°C) for 1 hour.

6. Each well was aspirated and washed 5 times with the Wash Solution using an automatic microplate washer. Blot dry by inverting plate on absorbent material.

7. 100 µL of the TMB Chromogen Solution was added to each well using a semi-automatic dispenser.

8. The wells were incubated at room temperature (~25°C) for 20 minutes. Exposure to direct sunlight was avoided.

9. 100 µL of the Stopping solution (0.2 M sulfuric acid) was added to each well using
a semi-automatic dispenser.

10. The absorbance of the solution in the wells was read within 30 minutes, using a microplate reader set to 450 nm.

5.7 **APPENDIX VIII**

PLASMA GLUCOSE ASSAY

Trinder's analytic method was used. This entails glucose oxidase enzyme buffered in phenoxylate and dissolved in a colour reagent. A solution constitution in 100mls contained:

Potassium dihydrogen sulphate	38.9mls
Disodium hydrogen sulphate	61.1mls
Glucose oxidase	1.0ml
Phenol	0.64ml
4-Aminophenaxone	20mg
Sodium	100mg

This solution was stored at 4°C before usage.

PROCEDURE:

e. 2mls of glucose oxidase containing solution is placed inside test tube.

f. 0.2ml of plasma which has been allowed to thaw and warmed to room
   temperature is added to the test tube.
g. The mixture is then incubated in a water bath at 37^{o}C for 15 mins
h. The mixture is allowed to cool down to room temperature and then observed for a colour change from colourless solution to a pink solution.
i. The absorbance is read in a spectrophotometer at the wavelength of 540nm.
j. The reading is then compared to that of a standard glucose solution with known glucose concentration.
k. Glucose estimation is calculated as follows:

$$\frac{\text{Reading for sample}}{\text{Reading for standard}} \times \text{Amount of glucose in standard}$$

5.8 APPENDIX IX

(Estimation of Lipids)

Estimation of triglycerides:

The method is based on a series of 4 enzymatic reactions.

The first step is the lipase-catalysed hydrolysis of triglycerides to glycerol and fatty acids as follows:

1) Triglycerides $\xrightarrow{\text{Lipase}}$ Glycerol + free fatty acids

Glycerol is then phosphorylated in an ATP requiring reaction catalysed by glycerol kinase as follows.

2) $\text{Glycerol} + \text{ATP} \underset{}{\overset{\text{glycerol kinase}}{\rightleftarrows}} \text{Glycerol 3 phosphate} + \text{ADP}$

Glycerophosphate is oxidised to dihydroxyacetone and H_2O_2 in a glycerophosphate oxidase catalysed reaction as follows.

3) $\text{Glycerol 3 phosphate} + O_2 \overset{\text{glycerol 3 phosphate oxidase}}{\rightleftarrows}$

Dihydroxyacetone phosphate$+H_2O_2$

Hydrogen peroxide then reacts with chlorophenol in a peroxidase catalysed reaction to form a pink dye (quinine immine).

4) H_2O_2 + 4-Chlorophenol + 4-Aminoantipyrine $\xrightarrow{\text{Peroxidase}}$ pink + H_2O

The intensity of colour produced is measured spectrophotometrically at 500nm, the concentration of which is proportional to the amount of triglyceride in the sample.

Estimation of total cholesterol

Total serum cholesterol will be estimated using three enzymatic reactions.

Cholesterol ester in serum is hydrolysed by cholesterol esterase to form fatty acid and cholesterol as follows:

1) Cholesterol ester $\xrightarrow{\text{Cholesterol esterase}}$ Cholesterol + free fatty acids

The 3-OH groups of cholesterol is than oxidized to a ketone in an oxygen requiring reaction catalysed by cholesterol oxidase as follows:

2) Cholesterol + O_2 $\xrightarrow{\text{Cholesterol oxidase}}$ Cholestone 413 + H_2O_2.

H_2O_2 then reacts with phenol in a peroxidase catalysed reaction that forms a pink dye as follows:

3) H_2O_2+ Phenol + 4-aminoantipyrine $\xrightarrow{\text{Peroxidase}}$ quinoneimine dye+2H_2O_2

The intensity of the pink colour formed is measured spectrophotometrically at 500nm and is proportional to the cholesterol concentration in the sample.

Estimation of high density lipoprotein (HDL) cholesterol

Principle: Polyanions react with positively charged groups on lipoprotein. Their action is facilitated by the presence of divalent cation, which interacts with negatively charged groups. When polyanions are added to an aliquot of plasma or serum, an immediate heavy precipitate is formed. Precipitation is complete within 10-15 minutes at room temperature. The precipitate is then sedimented by centrifugation and HDL-Cholesterol is measured in the clear supernatant spectophotometrically at 500nm.

5.9 APPENDIX X

JNC 7 CLASSIFICATION OF HYPERTENSION

Category	SBP mmHg/ DBP mmHg
Normal	<120 / <80
Prehypertension	120–139 / 80–89
Hypertension, Stage 1	140–159 / 90–99
Hypertension, Stage 2	>160 / >100

SBP = Systolic blood pressure
DBP = Diastolic blood pressure

Source: (ref.58)

DATA

s/n	age	sex	H	W	BMI	WC	HC	WH	SBP	DBP	fpg	2hp	cpg	TC	HDL	LDL	TG	FI	HOM	locat
1	25	f	146	33	15.2	59	79	0.75	124	87	5.1	5.5	_	111	46	39	181	7.2	1.632	rural
2	65	f	152	43	18.6	61	83	0.73	130	90	4.7	5.3	_	135	52	95	67	1.9	0.397	rural
3	65	f	154	44	18.6	62	84	0.74	136	90	4.7	_	_	_	_	_	_	_	_	rural

4	30	f	161	46	17.7	64	83	0.77	140	90	6.7	_	_	_	_	_	_	_	_	rural
5	40	f	160	50	19.5	64	84	0.76	160	100	_	_	13	_	_	_	_	_	_	rural
6	27	f	161	53	20.4	64	72	0.89	130	82	4.2	_	_	_	_	_	_	_	_	rural
7	50	f	158	41	16.4	65	77	0.84	134	82	_	_	6.6	_	_	_	_	_	_	rural
8	30	f	152	42	18.2	65	77	0.84	106	72	_	_	7.5	_	_	_	_	_	_	rural
9	50	f	160	45	17.6	65	80	0.81	150	110	_	_	7.5	_	_	_	_	_	_	rural
10	20	f	146	42	19.7	65	87	0.75	132	80	_	_	7	_	_	_	_	_	_	rural
11	50	f	160	45	17.6	65	80	0.81	134	80	_	_	6.3	_	_	_	_	_	_	rural
12	27	f	165	43	15.8	66	76	0.87	130	80	4.7	_	_	_	_	_	_	_	_	rural
13	50	f	163	54	20.3	66	82	0.8	107	62	5.1	_	_	_	_	_	_	_	_	rural
14	30	f	160	54	21.1	66	88	0.75	134	74	5.2	5.8	_	141	50	77	110	76	17.56	rural
15	50	f	155	45	18.7	66	79	0.84	120	80	_	_	7.5	_	_	_	_	_	_	rural
16	28	f	145	46	21.9	66	80	0.83	122	62	4.3	4.9	_	159	54	113	52	10	1.911	rural
17	55	f	151	36	15.8	67	74	0.91	110	60	_	_	6.1	_	_	_	_	_	_	rural
18	25	f	161	49	18.9	68	82	0.83	120	80	_	_	5.3	_	_	_	_	_	_	rural
19	40	f	167	58	20.8	68	83	0.82	124	70	4.9	_	_	_	_	_	_	_	_	rural
20	30	f	145	41	19.5	68	86	0.79	135	76	_	_	5.2	_	_	_	_	_	_	rural
21	20	f	156	46	18.9	69	80	0.86	110	60	_	_	5.5	_	_	_	_	_	_	rural
22	30	f	164	51	19	69	89	0.78	110	80	_	_	6.2	_	_	_	_	_	_	rural
23	35	f	160	48	18.8	69	92	0.75	120	80	5.1	_	_	_	_	_	_	_	_	rural
24	20	f	161	46	17.7	69	85	0.81	140	81	4.8	_		_	_	_	_	_	_	rural
25	35	f	160	54	21.1	70	90	0.78	139	86	4.5	5.3		123	62	70	84	6.1	1.22	rural
26	25	f	158	52	20.8	70	88	0.8	110	80	4.6	_	_	_	_	_	_	_	_	rural
27	50	f	154	43	18.1	70	81	0.86	180	90	_	_	15	_	_	_	_	_	_	rural
28	30	f	153	50	21.4	70	82	0.85	130	70	5.3	_	_	_	_	_	_	_	_	rural
29	45	f	158	42	16.6	70	86	0.81	131	79	4.5	_	_	_	_	_	_	_	_	rural
30	30	f	170	56	19.4	70	84	0.83	130	81	_	_	5.4	_	_	_	_	_	_	rural
31	65	f	154	51	21.5	71	90	0.79	170	100	6.8	8.2	_	158	36	92	148	14	4.08	rural
32	50	f	146	43	20.2	71	82	0.87	130	90	5.3	_	_	_	_	_	_	_	_	rural
33	64	f	165	48	17.6	71	90	0.79	120	80	_	_	9.9	_	_	_	_	_	_	rural
34	25	f	157	52	21.1	71	87	0.82	120	86	3.8	_	_	_	_	_	_	_	_	rural
35	35	f	152	35	15.1	71	89	0.8	140	75	5.2	_	_	_	_	_	_	_	_	rural
36	30	f	150	48	21.3	71	94	0.76	97	60	5	_	_	_	_	_	_	_	_	rural
37	25	f	152	53	22.9	72	89	0.81	120	80	4.4	_	_	_	_	_	_	_	_	rural
38	25	f	161	57	22	72	83	0.87	130	63	5.5	6.1	_	146	51	86	110	1.6	0.391	rural
39	35	f	165	56	20.6	72	89	0.81	137	87	5.3	_	_	_	_	_	_	_	_	rural
40	18	f	155	60	25	72	89	0.81	110	90	_	_	4.6	_	_	_	_	_	_	rural
41	30	f	157	53	21.5	72	93	0.77	130	80	3.6	_	_	_	_	_	_	_	_	rural
42	25	f	167	58	20.8	72	88	0.82	134	63	4.7	_	_	_	_	_	_	_	_	rural
43	25	f	154	49	20.7	72	89	0.81	127	78	5.3	_	_	_	_	_	_	_	_	rural
44	28	f	158	45	18	72	87	0.83	108	67	_	_	5.9	_	_	_	_	_	_	rural
45	30	f	155	54	22.5	72	88	0.82	110	70	4.8	_	_	_	_	_	_	_	_	rural
46	35	f	165	56	20.6	72	89	0.81	136	87	5	_	_	_	_	_	_	_	_	rural
47	32	f	158	52	20.8	72	80	0.9	134	86	4.4	_	_	_	_	_	_	_	_	rural
48	45	f	175	54	17.6	73	90	0.81	120	80	5.4	6.7		206	25	155	129	8.4	2.016	rural
49	30	f	155	53	22.1	73	91	0.8	120	60	4.8	5.7	_	135	58	48	123	11	2.347	rural
50	20	f	156	60	24.7	73	90	0.81	127	74	_	_	5.2	_	_	_	_	_	_	rural
51	20	f	145	42	19.7	73	95	0.77	128	66	_	_	5.1	_	_	_	_	_	_	rural
52	25	f	158	50	20	73	91	0.8	140	86	5	_	_	_	_	_	_	_	_	rural
53	25	f	158	51	20.4	73	89	0.82	122	78	4.6	_	_	_	_	_	_	_	_	rural

54	50	f	154	52	21.9	74	80	0.93	170	100	5.9	_	_	_	_	_	_	_	_	rural
55	24	f	159	62	24.5	74	92	0.8	152	98	_	_	5.7	_	_	_	_	_	_	rural
56	37	f	166	59	21.4	74	83	0.89	130	80	_	_	5.1	_	_	_	_	_	_	rural
57	20	f	156	50	20.5	74	89	0.83	126	78	5.4	_	_	_	_	_	_	_	_	rural
58	25	f	169	54	18.9	74	87	0.85	100	70	4.5	_	_	_	_	_	_	_	_	rural
59	40	f	168	56	19.8	74	86	0.86	120	80	4.9	_	_	_	_	_	_	_	_	rural
60	50	f	155	50	20.8	74	96	0.77	140	83	_	_	6.6	_	_	_	_	_	_	rural
61	30	f	151	46	20.2	74	85	0.87	112	65	_	_	5.6	_	_	_	_	_	_	rural
62	55	f	168	58	20.5	74	92	0.8	140	90	_	_	7.4	_	_	_	_	_	_	rural
63	60	f	159	51	20.2	75	85	0.88	133	77	_	_	7	_	_	_	_	_	_	rural
64	25	f	169	52	18.2	75	97	0.77	120	70	4.7	_	_	_	_	_	_	_	_	rural
65	45	f	160	42	16.4	75	88	0.85	138	86	4.9	5.5	_	94	59	42	52	1.2	0.261	rural
66	18	f	167	57	20.4	75	89	0.84	110	70	4.8	_	_	_	_	_	_	_	_	rural
67	30	f	153	56	23.9	75	94	0.8	116	75	5.1	_	_	_	_	_	_	_	_	rural
68	40	f	161	78	30.1	75	91	0.82	140	88	4.7	_	_	_	_	_	_	_	_	rural
69	35	f	154	48	20.2	75	94	0.8	127	80	_	_	6.8	_	_	_	_	_	_	rural
70	25	f	146	48	22.5	75	88	0.85	118	80	_	_	6.5	_	_	_	_	_	_	rural
71	17	f	153	50	21.4	75	89	0.84	124	74	4.9	_	_	_	_	_	_	_	_	rural
72	22	f	158	60	24	75	90	0.83	140	87	_	_	5.7	_	_	_	_	_	_	rural
73	34	f	174	67	22.1	75	97	0.77	121	63	5.3			_	_	_	_	_	_	rural
74	20	f	156	59	24.2	75	91	0.82	124	80	4.7	5.4	_	146	53	107	110	14	2.82	rural
75	30	f	151	50	21.9	76	84	0.9	130	80	_	_	6.3	_	_	_	_	_	_	rural
76	50	f	167	59	21.2	76	94	0.81	136	70	_	_	7.4	_	_	_	_	_	_	rural
77	23	f	164	54	20.1	76	96	0.79	120	80	4.7	_	_	_	_	_	_	_	_	rural
78	50	f	167	63	22.6	76	96	0.79	118	76	_	_	6.4	_	_	_	_	_	_	rural
79	27	f	163	58	21.8	76	104	0.73	126	84	4.3	7.1	_	158	62	86	150	7.3	1.395	rural
80	20	f	159	53	21	76	90	0.84	124	73	4.7	_	_	_	_	_	_	_	_	rural
81	45	f	153	45	19.2	76	85	0.89	114	66	4.8	_	_	_	_	_	_	_	_	rural
82	30	f	156	49	19.9	76	86	0.88	132	86	_	_	7.1	_	_	_	_	_	_	rural
83	55	f	155	51	21.2	76	90	0.84	150	97	6	_	_	_	_	_	_	_	_	rural
84	25	f	165	56	20.6	76	93	0.82	130	90	_	_	7.3	_	_	_	_	_	_	rural
85	33	f	165	51	18.7	76	95	0.8	120	70	4.7	_	_	_	_	_	_	_	_	rural
86	25	f	156	60	24.7	76	90	0.84	120	70	4.5	_	_	_	_	_	_	_	_	rural
87	25	f	167	58	20.8	77	92	0.84	132	88	_	_	7.7	_	_	_	_	_	_	rural
88	30	f	155	54	22.5	77	83	0.93	120	80	_	_	6	_	_	_	_	_	_	rural
89	20	f	165	58	21.3	77	82	0.94	116	73	4.7	_	_	_	_	_	_	_	_	rural
90	34	f	174	70	23.1	77	99	0.78	113	55	4.6	6.7	_	147	53	105	57	6.5	1.329	rural
91	25	f	169	50	17.5	77	95	0.81	130	90	4.7	_	_	_	_	_	_	_	_	rural
92	40	f	155	51	21.2	77	93	0.83	136	88	6	6.6	_	176	58	103	65	6.7	1.787	rural
93	30	f	172	54	18.1	77	92	0.84	120	86	_	_	6.1	_	_	_	_	_	_	rural
94	25	f	152	48	20.8	77	97	0.79	116	77	5	_	_	_	_	_	_	_	_	rural
95	30	f	155	54	22.5	77	83	0.93	120	80	_	_	6	_	_	_	_	_	_	rural
96	62	f	159	53	21	77	89	0.87	130	80	_	_	7	_	_	_	_	_	_	rural
97	30	f	157	53	21.5	77	84	0.92	138	88	_	_	4.3	_	_	_	_	_	_	rural
98	38	f	164	57	21.2	77	93	0.83	128	84	5.2	_	_	_	_	_	_	_	_	rural
99	40	f	156	55	22.6	78	92	0.85	106	64	_	_	7.1	_	_	_	_	_	_	rural
100	20	f	150	56	24.9	78	98	0.8	131	84	5.3	_	_	_	_	_	_	_	_	rural
101	38	f	159	48	19	78	92	0.85	127	85	5.5	6.7	_	170	57	132	117	4.1	1.002	rural
102	52	f	169	66	23.1	78	105	0.74	110	80	_	_	6.5	_	_	_	_	_	_	rural
103	33	f	156	61	25.1	78	91	0.86	126	80	4.5	6.6		162	67	89	145	3.2	0.64	rural

104	50	f	168	57	20.2	79	92	0.86	130	90	_	_	6.7	_	_	_	_	_	_	rural
105	19	f	156	50	20.5	79	86	0.92	110	60	4.3	6.2	_	129	51	74	77	4	0.764	rural
106	40	f	167	57	20.4	79	87	0.91	110	70	_	_	5.8	_	_	_	_	_	_	rural
107	45	f	160	55	21.3	79	105	0.75	125	83	3.8	_		_	_	_	_	_	_	rural
108	50	f	154	50	21.1	79	87	0.91	120	74	_	_	6.8	_	_	_	_	_	_	rural
109	46	f	154	50	21.1	79	87	0.91	130	74	5	_	_	_	_	_	_	_	_	rural
110	35	f	164	58	21.6	79	89	0.89	121	88	5.3	_	_	_	_	_	_	_	_	rural
111	40	f	156	50	20.5	79	92	0.86	138	80	_	_	7.9	_	_	_	_	_	_	rural
112	63	f	168	57	20.2	79	92	0.86	130	90	_	_	6.7	_	_	_	_	_	_	rural
113	60	f	155	56	23.3	79	96	0.82	120	80	5.3	_	_	_	_	_	_	_	_	rural
114	47	f	154	60	25.3	79	97	0.81	138	70	_	_	8.8	_	_	_	_	_	_	rural
115	30	f	157	66	26.8	80	95	0.84	126	80	4.9	_	_	_	_	_	_	_	_	rural
116	45	f	165	61	22.4	80	88	0.91	140	73	_	_	6.6	_	_	_	_	_	_	rural
117	22	f	157	62	25.2	80	100	0.8	136	88	_	_	5.9	_	_	_	_	_	_	rural
118	27	f	167	57	20.4	80	92	0.87	130	80	4.8	_	_	_	_	_	_	_	_	rural
119	21	f	168	74	26.2	80	99	0.81	120	80	4.3	_	_	_	_	_	_	_	_	rural
120	20	f	158	58	23.2	81	99	0.82	100	70	4.8			_	_	_	_	_	_	rural
121	25	f	163	63	23.7	81	91	0.89	130	90	_	_	7.2	_	_	_	_	_	_	rural
122	30	f	165	65	23.9	81	97	0.84	110	90	4.8	_	_	_	_	_	_	_	_	rural
123	20	f	168	76	26.9	81	104	0.78	110	80	4.5	_	_	_	_	_	_	_	_	rural
124	25	f	159	59	23.3	81	95	0.85	136	75	5.1	_	_	_	_	_	_	_	_	rural
125	35	f	151	50	21.9	81	89	0.91	130	73	5.1	_	_	_	_	_	_	_	_	rural
126	40	f	165	58	21.3	81	108	0.75	140	89	_	_	7	_	_	_	_	_	_	rural
127	30	f	156	58	23.8	81	98	0.83	130	88	4.4	_	_	_	_	_	_	_	_	rural
128	50	f	145	51	24.3	81	90	0.9	116	84	_	_	6.8	_	_	_	_	_	_	rural
129	44	f	150	55	24.4	81	97	0.84	132	78	_	_	5.7	_	_	_	_	_	_	rural
130	23	f	159	57	22.5	81	95	0.85	110	80	4.7	_	_	_	_	_	_	_	_	rural
131	60	f	147	54	25	81	100	0.81	130	60	_	_	7.5	_	_	_	_	_	_	rural
132	50	f	169	58	20.3	81	98	0.83	116	76	4.4	_	_	_	_	_	_	_	_	rural
133	52	f	168	61	21.6	81	94	0.86	110	68	4	_	_	_	_	_	_	_	_	rural
134	30	f	155	57	23.7	82	96	0.85	130	80	_	_	6.7	_	_	_	_	_	_	rural
135	35	f	152	58	25.1	82	96	0.85	132	86	5	_	_	_	_	_	_	_	_	rural
136	60	f	155	57	23.7	82	95	0.86	140	80	5.3	_	_	_	_	_	_	_	_	rural
137	30	f	163	62	23.3	82	100	0.82	140	88	_	_	4.4	_	_	_	_	_	_	rural
138	60	f	150	52	23.1	82	99	0.83	126	80	_	_	7.5	_	_	_	_	_	_	rural
139	50	f	169	60	21	82	92	0.89	100	70	4.9	_	_	_	_	_	_	_	_	rural
140	30	f	157	60	24.1	82	90	0.91	126	74	5.3	_	_	_	_	_	_	_	_	rural
141	27	f	143	54	26.4	82	103	0.8	133	86	_	_	7.1	_	_	_	_	_	_	rural
142	50	f	146	42	19.5	82	89	0.92	135	85	4.6	_	_	_	_	_	_	_	_	rural
143	40	f	155	59	24.6	82	100	0.82	140	72	6.2	9.3	_	177	34	120	108	48	13.23	rural
144	40	f	161	60	23.1	83	90	0.92	140	87	_	_	5.8	_	_	_	_	_	_	rural
145	40	f	150	57	25.3	83	94	0.88	130	90	_	_	5.7	_	_	_	_	_	_	rural
146	40	f	156	60	24.7	83	94	0.88	135	80	_	_	8.5	_	_	_	_	_	_	rural
147	40	f	173	70	23.4	83	93	0.89	130	60	5.4	_	_	_	_	_	_	_	_	rural
148	60	f	143	46	22.5	83	95	0.87	140	88	_	_	6.6	_	_	_	_	_	_	rural
149	25	f	162	60	22.9	84	97	0.87	140	86	_	_	5.7	_	_	_	_	_	_	rural
150	22	f	159	60	23.7	84	92	0.91	117	73	4.7	_	_	_	_	_	_	_	_	rural
151	50	f	149	58	26.1	84	95	0.88	130	90	_	_	5.3	_	_	_	_	_	_	rural
152	55	f	159	53	21	84	92	0.91	130	90	5.3	_	_	_	_	_	_	_	_	rural
153	60	f	155	51	21.2	84	99	0.85	134	90	4.9	_	_	_	_	_	_	_	_	rural

154	21	f	166	57	20.7	84	93	0.9	130	80	_	_	7	_	_	_	_	_	_	rural
155	24	f	162	60	22.9	84	97	0.87	140	86	_	_	5.7	_	_	_	_	_	_	rural
156	35	f	157	65	26.4	84	97	0.87	140	90	_	_	3.5	_	_	_	_	_	_	rural
157	40	f	163	58	21.8	86	91	0.95	140	80	_	_	9.6	_	_	_	_	_	_	rural
158	20	f	164	61	22.7	87	96	0.91	120	80	4.5	_	_	_	_	_	_	_	_	rural
159	50	f	151	63	27.6	87	98	0.89	140	90	5.1	5.7	_	182	55	106	103	2	0.453	rural
160	20	f	167	63	22.6	87	92	0.95	120	60	_	_	6	_	_	_	_	_	_	rural
161	60	f	152	53	22.9	87	95	0.92	140	90	_	_	7	_	_	_	_	_	_	rural
162	64	f	150	58	25.8	87	100	0.87	138	70	_	_	7.6	_	_	_	_	_	_	rural
163	19	f	164	61	22.7	87	96	0.91	120	80	4.9	_	_	_	_	_	_	_	_	rural
164	30	f	163	65	24.5	88	99	0.89	128	90	4.4	4.9	_	158	63	101	107	5.4	1.056	rural
165	37	f	166	62	22.5	89	99	0.9	122	72	_	_	6.1	_	_	_	_	_	_	rural
166	47	f	169	63	22.1	89	106	0.84	128	84	5.3	_	_	_	_	_	_	_	_	rural
167	50	f	161	63	24.3	90	95	0.95	140	90	4.7	_	_	_	_	_	_	_	_	rural
168	22	f	172	76	25.7	90	100	0.9	144	104	6.1	_	_	_	_	_	_	_	_	rural
169	49	f	155	47	19.6	91	94	0.97	130	79	5.1	5.7	_	142	57	69	136	1.6	0.363	rural
170	63	f	151	50	21.7	92	89	1.03	213	90	6.1	_	_	_	_	_	_	_	_	rural
171	40	f	159	67	26.5	93	99	0.94	130	88	4.2	6.1	_	129	54	76	45	32	6.048	rural
172	45	f	155	68	28.3	93	102	0.91	130	90	4.2	_	_	_	_	_	_	_	_	rural
173	47	f	169	65	22.8	95	99	0.96	120	80	5.3	6.8	_	182	51	153	123	3.4	0.801	rural
174	25	f	160	75	29.1	95	102	0.93	140	90	_	_	7.1	_	_	_	_	_	_	rural
175	50	f	154	72	30.4	96	107	0.9	120	90	_	_	5.2	_	_	_	_	_	_	rural
176	35	f	155	77	32	97	100	0.97	128	90	6.9	_	_	_	_	_	_	_	_	rural
177	60	f	154	75	31.6	97	108	0.9	140	89	4.8	_	_	_	_	_	_	_	_	rural
178	50	f	170	78	27	98	106	0.92	140	80	_	_	6.3	_	_	_	_	_	_	rural
179	25	f	164	70	26	98	101	0.97	130	87	_	_	6.1	_	_	_	_	_	_	rural
180	45	f	158	78	31.2	100	113	0.88	126	83	_	_	6.7	_	_	_	_	_	_	rural
181	37	f	166	63	22.9	101	106	0.95	120	70	_	_	6.1	_	_	_	_	_	_	rural
182	28	f	175	98	32	107	121	0.88	120	80	4.8	_	_	_	_	_	_	_	_	rural
183	40	f	167	98	35.1	111	126	0.88	160	100	4.3	4.8	_	161	59	67	147	6.2	1.185	rural
184	18	m	160	46	18	63	81	0.78	130	59	4.5	7.3		155	53	56	123	18	3.6	rural
185	18	m	162	43	16.4	64	77	0.83	110	70	_	_	7	_	_	_	_	_	_	rural
186	30	m	165	51	18.7	65	88	0.74	120	70	4.6	4.7	_	135	48	79	39	8.5	1.738	rural
187	25	m	164	46	17.1	65	79	0.82	112	63	5.7	_	_	_	_	_	_	_	_	rural
188	65	m	170	42	14.5	66	77	0.86	120	80	4.3	4.9	_	145	53	97	101	9.6	1.835	rural
189	60	m	154	63	26.6	66	75	0.88	120	70	5.1	_	_	_	_	_	_	_	_	rural
190	19	m	156	45	18.5	66	81	0.81	110	70	_	_	7.3	_	_	_	_	_	_	rural
191	33	m	167	52	18.6	67	83	0.8	110	73	4.6	_	_	_	_	_	_	_	_	rural
192	63	m	158	47	18.8	67	77	0.87	138	76	_	_	6.9	_	_	_	_	_	_	rural
193	21	m	165	55	20.2	67	88	0.76	110	50	_	_	4.4	_	_	_	_	_	_	rural
194	19	m	157	50	20.3	67	84	0.8	140	70		_	6	_	_	_	_	_	_	rural
195	23	m	165	60	22	67	89	0.75	110	60	_	_	6.3	_	_	_	_	_	_	rural
196	63	m	160	50	19.5	67	77	0.87	130	70	_	_	6.9	_	_	_	_	_	_	rural
197	29	m	162	47	17.9	67	80	0.84	118	70	_	_	7	_	_	_	_	_	_	rural
198	60	m	165	52	19.1	68	84	0.81	140	83	_	_	6.8	_	_	_	_	_	_	rural
199	48	m	165	51	18.7	68	83	0.82	110	80	5.3	_	_	_	_	_	_	_	_	rural
200	19	m	150	50	22.2	68	82	0.83	130	50	_	_	7	_	_	_	_	_	_	rural
201	36	m	157	47	18.9	69	83	0.83	128	70	_	_	5.3	_	_	_	_	_	_	rural
202	50	m	166	53	19.2	69	87	0.79	124	80	5.4	_	_	_	_	_	_	_	_	rural
203	55	m	155	47	19.6	69	84	0.82	139	80	4.8	5.9	_	164	44	150	71	42	8.96	rural

204	25	m	170	62	21.5	69	90	0.77	130	70	5.4	6.6	_	111	50	55	110	1.3	0.312	rural
205	28	m	165	58	21.3	69	81	0.85	110	60	5	_	_	_	_	_	_	_	_	rural
206	19	m	160	57	22.3	69	89	0.78	120	70	5.5	6.3	_	118	61	69	77	14	3.447	rural
207	26	m	170	54	18.7	69	86	0.8	110	70	_	_	7	_	_	_	_	_	_	rural
208	18	m	159	56	22.2	70	88	0.8	120	55	_	_	6.5	_	_	_	_	_	_	rural
209	32	m	162	52	19.8	70	84	0.83	130	80	_	_	6.7	_	_	_	_	_	_	rural
210	56	m	164	53	19.7	70	86	0.81	130	86	5.3	6.2		126	51	68	126	5.9	1.39	rural
211	22	m	163	56	21.1	70	87	0.8	110	90	5.2	_	_	_	_	_	_	_	_	rural
212	18	m	165	60	22	70	85	0.82	130	70	4.9	_	_	_	_	_	_	_	_	rural
213	17	m	165	47	17.3	70	81	0.86	120	78	_	_	5.9	_	_	_	_	_	_	rural
214	60	m	165	50	18.4	70	80	0.88	140	81	_	_	6.6	_	_	_	_	_	_	rural
215	30	m	163	53	19.9	71	91	0.78	110	70	_	_	5.7	_	_	_	_	_	_	rural
216	40	m	160	51	19.9	71	85	0.84	130	90	_	_	5.1	_	_	_	_	_	_	rural
217	25	m	170	61	21.1	71	95	0.75	110	72	4.3	_	_	_	_	_	_	_	_	rural
218	28	m	167	60	21.5	71	84	0.85	140	80	5.3	_	_	_	_	_	_	_	_	rural
219	40	m	149	42	18.7	71	86	0.83	154	96	_	_	7	_	_	_	_	_	_	rural
220	35	m	170	60	20.8	71	87	0.82	118	70	4.5	_	_	_	_	_	_	_	_	rural
221	46	m	170	53	18.3	71	85	0.84	118	78	5.1	_	_	_	_	_	_	_	_	rural
222	52	m	166	56	20.1	71	86	0.83	139	89	4.7	_	_	_	_	_	_	_	_	rural
223	46	m	170	51	17.6	72	85	0.85	115	80	4.8	5.9	_	135	50	71	71	1.3	0.277	rural
224	26	m	179	63	19.7	72	90	0.8	112	70	5.3	_	_	_	_	_	_	_	_	rural
225	60	m	167	51	18.3	72	88	0.82	136	80	_	_	8.1	_	_	_	_	_	_	rural
226	34	m	170	62	21.5	72	85	0.85	120	76	6	_	_	_	_	_	_	_	_	rural
227	37	m	169	60	21	72	82	0.88	124	72	_	_	6.1	_	_	_	_	_	_	rural
228	56	m	164	52	19.3	72	87	0.83	124	80	5.3	_	_	_	_	_	_	_	_	rural
229	17	m	170	58	20.1	72	86	0.84	110	70	5.3	_	_	_	_	_	_	_	_	rural
230	25	m	165	50	18.4	72	83	0.87	118	60	4.6	_	_	_	_	_	_	_	_	rural
231	20	m	180	60	18.5	72	88	0.82	115	70	4.2	_	_	_	_	_	_	_	_	rural
232	19	m	165	54	19.8	72	90	0.8	115	65	5.4	_	_	_	_	_	_	_	_	rural
233	21	m	168	58	20.5	72	78	0.92	115	75	4.7	_	_	_	_	_	_	_	_	rural
234	35	m	172	53	17.9	72	86	0.84	122	76	5.2	_	_	_	_	_	_	_	_	rural
235	32	m	165	53	19.5	73	87	0.83	110	70	_	_	6.9	_	_	_	_	_	_	rural
236	64	m	160	48	18.8	73	86	0.85	140	80	_	_	8.3	_	_	_	_	_	_	rural
237	45	m	169	55	19.3	73	84	0.87	120	80	_	_	7.1	_	_	_	_	_	_	rural
238	45	m	165	62	22.8	73	89	0.82	130	90	5.3	_	_	_	_	_	_	_	_	rural
239	25	m	163	55	20.7	73	87	0.84	128	80	6	_	_	_	_	_	_	_	_	rural
240	37	m	170	60	20.8	73	82	0.89	120	70	_	_	6.1	_	_	_	_	_	_	rural
241	25	m	170	60	20.8	73	96	0.76	100	70	_	_	7.1	_	_	_	_	_	_	rural
242	18	m	161	55	21.2	73	89	0.82	132	70	4.4	_	_	_	_	_	_	_	_	rural
243	57	m	158	52	20.8	73	87	0.84	116	78	_	_	6.7	_	_	_	_	_	_	rural
244	52	m	156	56	22.8	74	89	0.83	140	70	5.8	_	_	_	_	_	_	_	_	rural
245	37	m	160	57	22.1	74	89	0.83	130	80	_	_	7.6	_	_	_	_	_	_	rural
246	43	m	172	63	21.3	74	93	0.8	126	84	_	_	6.5	_	_	_	_	_	_	rural
247	24	m	175	62	20.2	74	88	0.84	140	68	4.8	6.5	_	194	59	90	126	6.4	1.365	rural
248	30	m	166	53	19.2	74	97	0.76	124	70	4.1	6.1	_	170	48	108	129	15	2.733	rural
249	57	m	158	51	20.4	74	80	0.93	110	70	_	_	11	_	_	_	_	_	_	rural
250	40	m	176	61	19.7	74	86	0.86	120	80	_	_	6.8	_	_	_	_	_	_	rural
251	53	m	160	45	17.6	74	85	0.87	110	70	4.1	_	_	_	_	_	_	_	_	rural
252	24	m	168	60	21.3	74	85	0.87	130	80	4.8	_	_	_	_	_	_	_	_	rural
253	52	m	156	55	22.4	74	89	0.83	140	70	5.8	_	_	_	_	_	_	_	_	rural

254	26	m	179	61	19	74	88	0.84	110	80	5.3	5.9	_	118	50	102	103	1.6	0.377	rural
255	48	m	177	62	19.8	74	88	0.84	120	80	_	_	7.6	_	_	_	_	_	_	rural
256	25	m	177	57	18.2	75	85	0.88	117	57	4.9	_	_	_	_	_	_	_	_	rural
257	21	m	165	55	20.2	75	81	0.92	140	80	_	_	7.2	_	_	_	_	_	_	rural
258	30	m	155	48	20	75	89	0.84	120	78	5.5	_	_	_	_	_	_	_	_	rural
259	35	m	179	66	20.6	75	89	0.84	120	70	5.5	_	_	_	_	_	_	_	_	rural
260	25	m	167	58	20.8	75	91	0.82	120	80	5.1	5.8	_	142	44	89	39	7.9	1.791	rural
261	35	m	160	55	21.5	75	87	0.86	110	70	5	_	_	_	_	_	_	_	_	rural
262	25	m	165	55	20.2	75	90	0.83	110	60	4.7	_	_	_	_	_	_	_	_	rural
263	56	m	170	57	19.7	75	88	0.85	122	73	_	_	6.3	_	_	_	_	_	_	rural
264	30	m	172	65	22	75	88	0.86	140	80	_	_	6.7	_	_	_	_	_	_	rural
265	40	m	177	60	19.2	75	91	0.82	118	68	_	_	6.8	_	_	_	_	_	_	rural
266	34	m	170	63	21.8	75	92	0.82	110	80	5.2	_	_	_	_	_	_	_	_	rural
267	55	m	165	62	22.8	76	91	0.84	130	90	_	_	6.8	_	_	_	_	_	_	rural
268	30	m	173	65	21.7	76	86	0.88	140	90	_	_	10	_	_	_	_	_	_	rural
269	27	m	171	64	21.7	76	93	0.82	120	70	_	_	7.3	_	_	_	_	_	_	rural
270	60	m	163	57	21.5	76	88	0.86	130	80	_	_	9.9	_	_	_	_	_	_	rural
271	50	m	168	57	20.2	76	89	0.85	135	80	4.3	_	_	_	_	_	_	_	_	rural
272	36	m	184	59	17.4	76	88	0.86	120	82	4.8	_	_	_	_	_	_	_	_	rural
273	30	m	158	54	21.6	76	86	0.88	140	80	_	_	4.6	_	_	_	_	_	_	rural
274	65	m	182	62	18.7	76	89	0.85	134	70		_	6.3	_	_	_	_	_	_	rural
275	55	m	165	62	22.8	76	91	0.84	130	90	_	_	6.8	_	_	_	_	_	_	rural
276	64	m	163	50	18.8	76	88	0.86	130	70	_	_	8.3	_	_	_	_	_	_	rural
277	20	m	169	58	20.3	77	90	0.86	120	70	_	_	6.3	_	_	_	_	_	_	rural
278	60	m	170	58	20.1	77	95	0.81	132	74	4.8	_	_	_	_	_	_	_	_	rural
279	27	m	165	68	25	77	96	0.8	140	80	4.6	_	_	_	_	_	_	_	_	rural
280	45	m	164	57	21.2	77	92	0.84	140	84	_		9.5	_	_	_	_	_	_	rural
281	20	m	170	61	21.1	77	93	0.83	120	70	_	_	5.6	_	_	_	_	_	_	rural
282	35	m	162	60	22.9	77	87	0.89	120	70	_	_	7.1	_	_	_	_	_	_	rural
283	65	m	153	42	17.9	77	82	0.94	100	60	_	_	7.7	_	_	_	_	_	_	rural
284	45	m	165	60	22	77	91	0.85	110	70	5.1	_	_	_	_	_	_	_	_	rural
285	40	m	170	57	19.7	77	88	0.88	130	68	_	_	5.6	_	_	_	_	_	_	rural
286	37	m	179	62	19.4	77	94	0.82	126	70	5.5	_	_	_	_	_	_	_	_	rural
287	36	m	184	63	18.6	77	93	0.83	128	78	4.8	_	_	_	_	_	_	_	_	rural
288	20	m	168	56	19.8	78	94	0.83	128	84	_	_	4.8	_	_	_	_	_	_	rural
289	40	m	170	58	20.1	78	88	0.89	130	70	_	_	5.6	_	_	_	_	_	_	rural
290	25	m	178	70	22.1	78	95	0.82	136	70	6.3	_	_	_	_	_	_	_	_	rural
291	44	m	175	63	20.6	78	91	0.86	110	60	6.1	_	_	_	_	_	_	_	_	rural
292	18	m	165	66	24.2	78	88	0.89	130	80	_	_	7.6	_	_	_	_	_	_	rural
293	25	m	168	63	22.3	78	92	0.85	110	60	_	_	7.4	_	_	_	_	_	_	rural
294	34	m	155	47	19.4	78	85	0.92	125	89	5.5	_	_	_	_	_	_	_	_	rural
295	42	m	183	72	21.5	78	92	0.85	131	60	6.3	_	_	_	_	_	_	_	_	rural
296	32	m	167	58	20.8	78	93	0.84	120	80	4.7	5.1	_	171	55	89	135	19	3.969	rural
297	45	m	163	58	21.8	79	92	0.85	150	80	_	_	11	_	_	_	_	_	_	rural
298	25	m	165	60	22	79	92	0.86	130	70	_	_	6.4	_	_	_	_	_	_	rural
299	60	m	159	52	20.6	79	89	0.89	135	70	6.2	_	_	_	_	_	_	_	_	rural
300	62	m	160	60	23.4	79	89	0.89	130	80	_	_	5.7	_	_	_	_	_	_	rural
301	28	m	170	64	22.1	79	86	0.92	110	60	_	_	7.5	_	_	_	_	_	_	rural
302	30	m	165	70	25.7	79	93	0.85	125	85	_	_	4.7	_	_	_	_	_	_	rural
303	28	m	167	61	21.9	79	94	0.84	140	80	_	_	6.4	_	_	_	_	_	_	rural

304	35	m	160	60	23.4	80	96	0.83	130	80	_	_	3.5	_	_	_	_	_	_	rural
305	28	m	167	61	21.9	80	96	0.83	130	80	_	_	6.1	_	_	_	_	_	_	rural
306	60	m	170	60	20.8	80	88	0.91	140	86	_	_	8.3	_	_	_	_	_	_	rural
307	36	m	160	54	21.1	80	96	0.83	130	90	_	_	16	_	_	_	_	_	_	rural
308	65	m	172	65	22	80	90	0.89	138	90	_	_	6.2	_	_	_	_	_	_	rural
309	38	m	179	63	19.7	80	97	0.82	128	80	6.8	_	_	_	_	_	_	_	_	rural
310	23	m	162	65	24.8	80	92	0.87	120	70	5.1	_	_	_	_	_	_	_	_	rural
311	29	m	175	75	24.5	80	97	0.82	118	75	_	_	6.9	_	_	_	_	_	_	rural
312	57	m	167	57	20.4	80	89	0.9	130	80	4.1	_	_	_	_	_	_	_	_	rural
313	42	m	178	64	20.2	80	94	0.85	128	82	6	_	_	_	_	_	_	_	_	rural
314	55	m	162	57	21.7	81	88	0.92	140	90	4.1	_	_	_	_	_	_	_	_	rural
315	30	m	156	62	25.5	81	88	0.92	120	80	_	_	5.6	_	_	_	_	_	_	rural
316	55	m	156	58	23.8	81	97	0.84	132	86	6.6	9.3	_	188	59	95	168	46	13.55	rural
317	35	m	160	62	24.2	81	92	0.88	120	76	5	_	_	_	_	_	_	_	_	rural
318	25	m	164	62	23.1	81	90	0.9	132	59	_	_	5.8	_	_	_	_	_	_	rural
319	38	m	179	66	20.6	81	92	0.88	130	80	4.7	_	_	_	_	_	_	_	_	rural
320	60	m	168	62	22	82	92	0.89	120	70	_	_	7.5	_	_	_	_	_	_	rural
321	22	m	156	61	25.1	82	92	0.89	120	70	_	_	4.4	_	_	_	_	_	_	rural
322	42	m	170	67	23	82	93	0.88	110	70	5.3	_	_	_	_	_	_	_	_	rural
323	53	m	163	57	21.5	82	89	0.92	130	85	5.3	_	_	_	_	_	_	_	_	rural
324	32	m	150	60	26.7	82	95	0.86	138	75	_	_	7.6	_	_	_	_	_	_	rural
325	59	m	172	60	20.1	82	89	0.92	140	80	_	_	8.3	_	_	_	_	_	_	rural
326	21	m	167	58	20.8	83	95	0.87	130	70	_	_	7	_	_	_	_	_	_	rural
327	52	m	160	51	19.9	83	94	0.88	130	80	_	_	5.4	_	_	_	_	_	_	rural
328	57	m	164	62	23.1	84	89	0.94	136	64	4.8	7.4	_	147	49	101	84	14	3.029	rural
329	40	m	172	63	21.3	84	96	0.88	130	80	_	_	5.8	_	_	_	_	_	_	rural
330	56	m	170	63	21.8	84	92	0.91	130	80	_	_	7.8	_	_	_	_	_	_	rural
331	35	m	155	51	21.2	84	91	0.92	130	78	_	_	6.7	_	_	_	_	_	_	rural
332	55	m	166	58	21	84	88	0.95	120	75	_	_	5.3	_	_	_	_	_	_	rural
333	52	m	160	50	19.5	84	93	0.9	130	80	5.2	_	_	_	_	_	_	_	_	rural
334	30	m	170	70	24.2	84	94	0.89	120	70	_	_	7.4	_	_	_	_	_	_	rural
335	38	m	165	68	25	84	95	0.88	110	60	4.3	_	_	_	_	_	_	_	_	rural
336	63	m	180	62	19.1	84	90	0.93	100	60	_	_	7.5	_	_	_	_	_	_	rural
337	57	m	171	62	21.2	84	88	0.95	133	76	_	_	7.3	_	_	_	_	_	_	rural
338	35	m	160	62	24.2	85	95	0.89	120	90	5.5	_	_	_	_	_	_	_	_	rural
339	40	m	151	57	25	85	92	0.92	140	80	_	_	5.2	_	_	_	_	_	_	rural
340	50	m	155	60	25	85	92	0.92	100	70	_	_	7.4	_	_	_	_	_	_	rural
341	30	m	165	73	26.8	85	99	0.86	130	70	5	_	_	_	_	_	_	_	_	rural
342	48	m	160	55	21.5	85	94	0.9	170	95		_	8	_	_	_	_	_	_	rural
343	63	m	175	67	21.9	85	92	0.92	160	100	_	_	6.2	_	_	_	_	_	_	rural
344	50	m	176	68	22	85	99	0.86	134	86	_	_	6	_	_	_	_	_	_	rural
345	38	m	177	74	23.5	86	98	0.88	130	87	_	_	5.3	_	_	_	_	_	_	rural
346	38	m	176	71	22.8	86	95	0.91	100	60	_	_	7.5	_	_	_	_	_	_	rural
347	55	m	156	60	24.7	86	92	0.93	140	89	_	_	8.5	_	_	_	_	_	_	rural
348	38	m	175	74	24.2	86	99	0.87	130	75	5.3	_	_	_	_	_	_	_	_	rural
349	38	m	167	55	19.5	87	87	0.99	130	70	5.2	_	_	_	_	_	_	_	_	rural
350	40	m	175	72	23.3	87	97	0.9	120	80	_	_	6.4	_	_	_	_	_	_	rural
351	24	m	160	60	23.4	87	78	1.12	136	86	5.3	7.1	_	153	55	105	88	16	3.792	rural
352	37	m	163	66	24.8	87	95	0.92	110	70	6.1	_	_	_	_	_	_	_	_	rural
353	35	m	157	65	26.4	87	97	0.9	130	70	_	_	7.3	_	_	_	_	_	_	rural

354	44	m	175	72	23.5	87	97	0.9	120	80	_	_	5.4	_	_	_	_	_	_	rural
355	39	m	178	80	25.2	88	97	0.91	130	88	4.4	7.9	_	159	41	103	103	20	3.97	rural
356	61	m	165	65	23.9	88	92	0.96	125	75	_	_	6.1	_	_	_	_	_	_	rural
357	50	m	176	70	22.6	88	92	0.96	134	90	_	_	7	_	_	_	_	_	_	rural
358	37	m	165	78	28.7	88	102	0.86	120	80	_	_	7.7	_	_	_	_	_	_	rural
359	37	m	168	74	26.2	88	105	0.84	120	70	4.2	6.1	_	167	50	87	132	1.5	0.28	rural
360	44	m	174	64	21.1	88	95	0.93	120	70	_	_	6.9	_	_	_	_	_	_	rural
361	50	m	177	64	20.4	88	90	0.98	138	88	_	_	5.8	_	_	_	_	_	_	rural
362	31	m	168	72	25.5	89	99	0.9	119	63	4	_	_	_	_	_	_	_	_	rural
363	37	m	173	78	26.1	89	106	0.84	130	70	_	_	6.8	_	_	_	_	_	_	rural
364	62	m	169	68	23.6	89	94	0.95	162	100	5.7	_	_	_	_	_	_	_	_	rural
365	53	m	166	72	26.1	89	99	0.9	130	76	5	7.3	_	169	39	107	155	82	18.22	rural
366	60	m	172	66	22.3	89	89	1	130	90	6.3	7.7	_	141	47	88	77	4	1.12	rural
367	63	m	168	68	24.1	90	96	0.94	158	98	4.1	6.3	_	91	52	87	64	12	2.187	rural
368	45	m	169	74	25.9	90	99	0.91	120	90	_	_	6.2	_	_	_	_	_	_	rural
369	30	m	174	76	24.9	90	101	0.89	111	72		_	5.8	_	_	_	_	_	_	rural
370	45	m	168	76	26.9	90	98	0.92	140	88	5	_	_	_	_	_	_	_	_	rural
371	50	m	160	65	25.4	90	99	0.91	138	90	5.4	5.7	_	154	53	90	113	3.9	0.936	rural
372	30	m	165	80	29.4	91	104	0.88	140	90	5.3	_	_	_	_	_	_	_	_	rural
373	40	m	165	62	22.8	91	101	0.9	120	70	_	_	9.2	_	_	_	_	_	_	rural
374	30	m	164	74	27.5	92	109	0.84	130	80	_	_	5.3	_	_	_	_	_	_	rural
375	65	m	167	65	23.3	92	101	0.91	135	75	_	_	_	_	_	_	_	_	_	rural
376	65	m	165	45	16.5	93	100	0.93	120	70	_	_	6.5	_	_	_	_	_	_	rural
377	35	m	172	79	26.7	94	100	0.94	105	70	4.9	_	_	_	_	_	_	_	_	rural
378	53	m	166	75	27.2	94	96	0.98	120	80	_	_	5.6	_	_	_	_	_	_	rural
379	41	m	165	75	27.5	94	103	0.91	110	70	_	_	7.1	_	_	_	_	_	_	rural
380	39	m	179	84	26.2	94	104	0.9	128	87	4.2	6.4	_	141	48	79	90	11	1.979	rural
381	45	m	160	67	26.2	95	104	0.91	130	80	4.5	7.7	_	141	44	76	103	14	2.86	rural
382	65	m	157	61	24.7	95	103	0.92	122	84	5.4	_	_	_	_	_	_	_	_	rural
383	64	m	165	70	25.7	95	93	1.02	130	80	6.2	6.8	_	129	47	87	64	34	9.369	rural
384	41	m	165	70	25.7	96	91	1.05	135	90	5.7	_	_	_	_	_	_	_	_	rural
385	37	m	170	78	26.8	96	98	0.98	117	69	_	_	6	_	_	_	_	_	_	rural
386	35	m	166	80	29	97	102	0.95	120	60	_	_	10	_	_	_	_	_	_	rural
387	60	m	160	67	26.2	98	102	0.96	120	70	_	_	6.7	_	_	_	_	_	_	rural
388	50	m	166	86	31	99	106	0.93	140	90	5.2	_	_	_	_	_	_	_	_	rural
389	60	m	182	94	28.4	100	113	0.88	120	60	5	6.6	_	123	38	48	187	1.6	0.356	rural
390	45	m	172	83	28.1	100	109	0.92	110	80	_	_	7.5	_	_	_	_	_	_	rural
391	45	m	167	81	28.9	100	103	0.97	130	90	5	_	_	_	_	_	_	_	_	rural
392	55	m	177	91	28.9	103	104	0.99	130	80	5.4	_	_	_	_	_	_	_	_	rural
393	55	m	167	67	24	108	115	0.94	160	90	_	_	6.2	_	_	_	_	_	_	rural
394	27	f	161	43	16.6	58	78	0.74	120	62	4.1	_	_	_	_	_	_	_	_	urban
395	27	f	160	39	15.2	61	79	0.77	118	70	3.8	_	_	_	_	_	_	_	_	urban
396	53	f	158	38	15.1	62	80	0.77	110	80	_	_	6.3	_	_	_	_	_	_	urban
397	25	f	162	47	17.9	62	83	0.75	100	60	4.9	_	_	_	_	_	_	_	_	urban
398	25	f	162	47	17.7	62	83	0.75	99	62	5.1	_	_	_	_	_	_	_	_	urban
399	35	f	155	36	15	64	82	0.78	129	86	5.6	_	_	_	_	_	_	_	_	urban
400	20	f	154	40	16.9	64	76	0.84	100	57	_	_	6.3	_	_	_	_	_	_	urban
401	30	f	149	42	18.9	64	84	0.76	120	60	5.1	6.2	_	123	56	69	90	6	1.36	urban
402	53	f	158	52	20.8	65	87	0.75	110	82	4.7	6.3	_	116	61	22	106	5.6	1.17	urban
403	18	f	160	44	17.2	65	90	0.72	116	60	_	_	5.7	_	_	_	_	_	_	urban

404	25	f	161	46	17.6	65	83	0.78	117	74	4.4	6.2	_	170	56	119	58	14	2.757	urban
405	30	f	150	41	18.2	66	84	0.79	120	68	4.9	_	_	_	_	_	_	_	_	urban
406	22	f	162	52	19.8	66	101	0.65	110	70	4.8	_	_	_	_	_	_	_	_	urban
407	25	f	159	48	19	66	83	0.8	120	74	5.3	_	_	_	_	_	_	_	_	urban
408	36	f	167	49	17.6	66	86	0.77	132	83	4.7	_	_	_	_	_	_	_	_	urban
409	25	f	158	49	19.6	67	86	0.78	120	60	5.2	_	_	_	_	_	_	_	_	urban
410	22	f	161	48	18.5	67	88	0.76	108	60	_	_	6.9	_	_	_	_	_	_	urban
411	19	f	158	44	17.6	68	78	0.87	112	60	_	_	6.1	_	_	_	_	_	_	urban
412	18	f	160	48	18.8	68	92	0.74	120	70	4.8	_	_	_	_	_	_	_	_	urban
413	30	f	156	52	21.2	68	98	0.69	112	66	4.1	_	_	_	_	_	_	_	_	urban
414	23	f	162	50	19.1	68	94	0.72	120	90	_	_	5.1	_	_	_	_	_	_	urban
415	22	f	160	49	19.1	69	88	0.78	110	60	_	_	6.6	_	_	_	_	_	_	urban
416	17	f	158	50	20	70	84	0.83	120	72	5.5	_	_	_	_	_	_	_	_	urban
417	20	f	158	54	21.6	70	98	0.71	138	90	5.1	_	_	_	_	_	_	_	_	urban
418	29	f	163	55	20.7	70	89	0.79	126	73	_	_	6.5	_	_	_	_	_	_	urban
419	40	f	163	52	19.6	70	89	0.79	136	78	5.4	_	_	_	_	_	_	_	_	urban
420	28	f	167	55	19.7	70	94	0.74	124	87	4.3	_	_	_	_	_	_	_	_	urban
421	28	f	167	55	19.7	70	94	0.74	124	87	4.5	_	_	_	_	_	_	_	_	urban
422	22	f	162	54	20.6	70	102	0.69	122	74	4.8	_	_	_	_	_	_	_	_	urban
423	17	f	156	47	19.3	71	84	0.85	119	71	5.5	_	_	_	_	_	_	_	_	urban
424	28	f	166	51	18.5	71	88	0.81	100	52	_	_	7.3	_	_	_	_	_	_	urban
425	27	f	160	54	21.1	72	94	0.76	110	70	_	_	6.4	_	_	_	_	_	_	urban
426	27	f	153	53	22.4	72	94	0.76	110	70	_	_	6.5	_	_	_	_	_	_	urban
427	30	f	156	50	20.5	72	94	0.77	110	70	4.1	_	_	_	_	_	_	_	_	urban
428	24	f	156	55	22.6	72	98	0.73	140	90	5.2	_	_	_	_	_	_	_	_	urban
429	19	f	156	50	20.5	73	87	0.84	116	72	5.3	_	_	_	_	_	_	_	_	urban
430	23	f	166	54	19.6	74	95	0.78	121	64	3.9	_	_	_	_	_	_	_	_	urban
431	27	f	149	55	24.8	74	98	0.76	120	70	5	_	_	_	_	_	_	_	_	urban
432	18	f	159	44	17.4	74	85	0.87	110	70	5.5	_	_	_	_	_	_	_	_	urban
433	38	f	166	68	24.7	75	95	0.79	124	80	_	_	17	_	_	_	_	_	_	urban
434	23	f	162	53	20.2	75	96	0.78	120	88	4.9	5.5	_	179	56	96	103	12	2.635	urban
435	36	f	169	54	18.9	76	91	0.84	132	80	4.9	_	_	_	_	_	_	_	_	urban
436	45	f	157	58	23.5	76	96	0.79	134	80	_	_	7.1	_	_	_	_	_	_	urban
437	60	f	150	48	21.3	76	79	0.96	135	72	4.3	4.6		153	55	88	52	2.1	0.401	urban
438	35	f	155	53	22.1	76	93	0.82	130	80	_	_	5.3	_	_	_	_	_	_	urban
439	17	f	156	57	23.4	76	80	0.95	120	70	5.4	_	_	_	_	_	_	_	_	urban
440	27	f	165	54	19.8	77	92	0.84	100	64	_	_	7	_	_	_	_	_	_	urban
441	60	f	153	55	23.5	77	86	0.9	130	75	4.3	_	_	_	_	_	_	_	_	urban
442	40	f	149	50	22.5	77	90	0.86	120	70	_	_	6.7	_	_	_	_	_	_	urban
443	29	f	158	60	24	77	92	0.84	120	70	_	_	5.2	_	_	_	_	_	_	urban
444	18	f	159	51	20.2	77	93	0.83	110	80	4.8	_	_	_	_	_	_	_	_	urban
445	40	f	163	56	21.1	77	93	0.83	127	70	5.3	_		_	_	_	_	_	_	urban
446	23	f	155	49	20.4	77	90	0.86	126	74	4.5	_	_	_	_	_	_	_	_	urban
447	40	f	163	53	19.9	77	93	0.83	120	70	4.9	_	_	_	_	_	_	_	_	urban
448	23	f	162	71	27.1	78	106	0.73	110	70	5.2	_	_	_	_	_	_	_	_	urban
449	16	f	155	61	25.4	78	105	0.74	110	70	4.7	_	_	_	_	_	_	_	_	urban
450	25	f	165	46	16.9	78	95	0.82	111	67	_	_	6.6	_	_	_	_	_	_	urban
451	24	f	166	57	20.7	78	97	0.8	120	80	3.9	_	_	_	_	_	_	_	_	urban
452	60	f	150	52	23.1	78	94	0.83	132	70	3.9	_	_	_	_	_	_	_	_	urban
453	37	f	155	62	25.8	78	99	0.79	120	70	_	_	6.4	_	_	_	_	_	_	urban

454	16	f	156	60	24.7	78	102	0.76	110	70	4.1	6		147	55	80	65	16	2.916	urban
455	45	f	150	51	22.6	78	91	0.86	136	81	_	_	6.7	_	_	_	_	_	_	urban
456	60	f	150	50	22.2	78	87	0.9	134	70	5.1	_	_	_	_	_	_	_	_	urban
457	37	f	157	63	25.6	79	99	0.8	130	70	_	_	6.1	_	_	_	_	_	_	urban
458	36	f	165	58	21.3	79	104	0.76	125	76	_	_	4.6	_	_	_	_	_	_	urban
459	17	f	149	54	24.3	79	96	0.82	120	70	_	_	6.2	_	_	_	_	_	_	urban
460	45	f	150	51	22.7	79	95	0.83	128	81	_	_	6.9	_	_	_	_	_	_	urban
461	40	f	149	48	21.4	79	89	0.89	116	69	_	_	6.4	_	_	_	_	_	_	urban
462	40	f	153	59	25.2	79	101	0.78	139	79	4.8	6.3		194	53	116	129	1.2	0.256	urban
463	17	f	148	55	25.1	79	97	0.81	112	64	_	_	6.6	_	_	_	_	_	_	urban
464	29	f	158	61	24.4	79	95	0.83	126	75	5.1	5.6	_	129	50	74	77	2	0.453	urban
465	22	f	163	57	21.5	80	99	0.81	122	68	_	_	6.6	_	_	_	_	_	_	urban
466	22	f	158	51	20.4	80	95	0.84	124	70	4.5	5.2	_	170	57	121	110	16	3.22	urban
467	45	f	154	56	23.6	80	94	0.85	140	80	_	_	7.1	_	_	_	_	_	_	urban
468	40	f	153	58	24.8	80	102	0.78	140	78	4.8	_	_	_	_	_	_	_	_	urban
469	26	f	158	63	25.2	80	99	0.81	99	58	_	_	5.2	_	_	_	_	_	_	urban
470	23	f	162	69	26.3	80	103	0.78	118	70	4.7	_	_	_	_	_	_	_	_	urban
471	40	f	164	70	25.8	81	107	0.76	119	70	5.4	_	_	_	_	_	_	_	_	urban
472	20	f	148	56	25.6	81	95	0.85	120	70	5.2	_	_	_	_	_	_	_	_	urban
473	22	f	149	56	25.2	81	97	0.84	124	74	5.2	_	_	_	_	_	_	_	_	urban
474	23	f	163	59	22.2	81	98	0.83	120	80	_	_	6.7	_	_	_	_	_	_	urban
475	40	f	164	63	23.4	81	96	0.84	124	68	5.3	_	_	_	_	_	_	_	_	urban
476	30	f	154	56	23.6	81	99	0.82	130	78	_	_	5.6	_	_	_	_	_	_	urban
477	36	f	165	59	21.7	81	97	0.84	122	70	4.1	_	_	_	_	_	_	_	_	urban
478	27	f	172	56	18.9	81	99	0.82	118	74	_	_	6.7	_	_	_	_	_	_	urban
479	20	f	147	58	26.6	81	94	0.86	116	66	5.1	_	_	_	_	_	_	_	_	urban
480	27	f	170	65	22.5	82	99	0.83	130	80	4.7	5.8	_	177	59	92	129	12	2.528	urban
481	64	f	154	59	24.9	82	97	0.85	120	70	6.3	_	_	_	_	_	_	_	_	urban
482	20	f	152	57	24.7	83	94	0.88	122	68	5.5	_	_	_	_	_	_	_	_	urban
483	26	f	158	61	24.4	83	98	0.85	118	64	4	5.7	_	206	37	127	77	21	3.733	urban
484	55	f	162	70	26.7	83	105	0.79	119	72	_	_	6	_	_	_	_	_	_	urban
485	47	f	151	55	24.1	83	94	0.88	110	68	5.5	7.3	_	186	56	88	107	4	0.978	urban
486	27	f	172	59	19.9	83	103	0.81	120	70	_	_	6.4	_	_	_	_	_	_	urban
487	40	f	163	55	20.7	83	99	0.84	130	80	5.3	6.8		191	46	184	123	1.4	0.33	urban
488	25	f	165	50	18.4	83	99	0.84	122	70	_	_	6.2	_	_	_	_	_	_	urban
489	64	f	154	57	24	83	96	0.86	120	63	6.5	_	_	_	_	_	_	_	_	urban
490	31	f	172	86	29.1	84	94	0.89	110	70	5.3	_	_	_	_	_	_	_	_	urban
491	64	f	157	60	24.3	84	98	0.86	120	70	6.3	_	_	_	_	_	_	_	_	urban
492	60	f	153	61	26.1	84	98	0.86	136	70	_	_	9	_	_	_	_	_	_	urban
493	63	f	168	74	26.2	84	98	0.86	128	84	5.1	_	_	_	_	_	_	_	_	urban
494	55	f	162	73	27.8	84	104	0.81	120	76	5.4	_	_	_	_	_	_	_	_	urban
495	26	f	155	64	26.6	85	110	0.77	140	88	5.2	5.7	_	153	50	83	97	6	1.387	urban
496	25	f	167	60	21.5	85	102	0.83	120	76	5	_	_	_	_	_	_	_	_	urban
497	56	f	157	59	23.9	85	99	0.86	130	80	6.1	8.3	_	200	48	133	97	90	24.4	urban
498	65	f	167	60	21.5	85	101	0.84	126	70	_	_	8.4	_	_	_	_	_	_	urban
499	60	f	153	60	25.6	85	99	0.86	129	64	_	_	8.8	_	_	_	_	_	_	urban
500	56	f	153	64	27.3	86	99	0.87	130	84	6.2	_	_	_	_	_	_	_	_	urban
501	40	f	151	68	29.8	86	102	0.84	118	68	8	_	_	_	_	_	_	_	_	urban
502	30	f	154	55	23.2	86	96	0.9	130	70	_	_	5.8	_	_	_	_	_	_	urban
503	22	f	162	66	25.1	86	107	0.8	128	85	4.4	_	_	_	_	_	_	_	_	urban

504	51	f	165	60	22	86	88	0.98	120	80	5.3	6.2	_	159	90	42	135	9.8	2.308	urban
505	40	f	151	66	28.9	86	102	0.84	115	67	5.2	6.9	_	174	36	134	155	32	7.396	urban
506	36	f	160	62	24.2	86	107	0.8	135	67	_	_	4.6	_	_	_	_	_	_	urban
507	29	f	157	71	28.8	86	107	0.8	120	80	5	_	_	_	_	_	_	_	_	urban
508	30	f	163	61	23	87	96	0.91	120	80	5.1	_	_	_	_	_	_	_	_	urban
509	45	f	158	64	25.6	87	105	0.83	113	71	4.7	_	_	_	_	_	_	_	_	urban
510	30	f	168	75	26.4	87	115	0.76	120	80	_	_	7.1	_	_	_	_	_	_	urban
511	27	f	170	63	21.8	87	103	0.84	120	76	4.4	5.1	_	167	50	54	155	1.8	0.352	urban
512	30	f	174	84	27.7	88	108	0.81	138	76	4.7	_	_	_	_	_	_	_	_	urban
513	48	f	165	67	24.6	88	100	0.88	120	60	_	_	5.7	_	_	_	_	_	_	urban
514	40	f	160	66	25.8	88	103	0.85	132	70	_	_	6.9	_	_	_	_	_	_	urban
515	45	f	158	65	26	88	100	0.88	124	74	4.4	_	_	_	_	_	_	_	_	urban
516	32	f	152	66	28.6	88	106	0.83	156	98	6.2	_	_	_	_	_	_	_	_	urban
517	23	f	157	72	29.2	88	107	0.82	120	88	4.5	_	_	_	_	_	_	_	_	urban
518	40	f	169	68	23.8	88	101	0.87	100	70	6.1	_	_	_	_	_	_	_	_	urban
519	30	f	168	71	25.2	88	104	0.85	126	78	_	_	7	_	_	_	_	_	_	urban
520	29	f	157	72	29.2	88	105	0.84	120	84	5	5.5	_	153	54	106	90	1	0.222	urban
521	30	f	156	72	29.6	88	96	0.92	138	88	_	_	7	_	_	_	_	_	_	urban
522	55	f	162	72	27.4	88	102	0.86	128	82	5.4	_	_	_	_	_	_	_	_	urban
523	33	f	167	72	25.8	88	102	0.86	134	86	_	_	7.4	_	_	_	_	_	_	urban
524	36	f	163	78	29.4	88	108	0.81	124	70	_	_	6.7	_	_	_	_	_	_	urban
525	64	f	157	61	24.7	88	99	0.89	120	80	6.5	_	_	_	_	_	_	_	_	urban
526	48	f	162	67	25.5	88	101	0.87	121	62	5.7	_	_	_	_	_	_	_	_	urban
527	64	f	157	69	28	88	98	0.9	120	80	_	_	6.9	_	_	_	_	_	_	urban
528	22	f	162	69	26.3	88	105	0.84	132	80	4.7	_	_	_	_	_	_	_	_	urban
529	32	f	152	64	27.7	88	98	0.9	190	110	6.7	9.3		197	37	143	98	19	5.688	urban
530	30	f	163	62	23.3	88	99	0.89	130	82	5.3	5.7	_	141	65	78	90	8	1.884	urban
531	51	f	165	61	22.4	88	98	0.9	120	70		_	6.7	_	_	_	_	_	_	urban
532	55	f	162	70	26.7	88	99	0.89	130	70	_	_	5.8	_	_	_	_	_	_	urban
533	29	f	172	80	27	88	96	0.92	130	80	_	_	8	_	_	_	_	_	_	urban
534	49	f	163	68	25.6	89	105	0.85	121	60	_	_	7.3	_	_	_	_	_	_	urban
535	60	f	155	49	20.4	89	90	0.99	132	90	4.3	6.4	_	94	53	45	77	14	2.695	urban
536	24	f	168	72	25.5	89	107	0.83	120	78	4.2	_	_	_	_	_	_	_	_	urban
537	34	f	170	72	24.9	89	103	0.86	110	70	5.3	6.7	_	165	53	105	129	5.4	1.272	urban
538	33	f	172	79	26.7	89	98	0.91	110	70	4.9	_	_	_	_	_	_	_	_	urban
539	49	f	163	68	25.4	89	105	0.85	117	64	_	_	6.9	_	_	_	_	_	_	urban
540	40	f	160	68	26.4	89	107	0.83	127	73	_	_	6.7	_	_	_	_	_	_	urban
541	23	f	157	70	28.4	89	108	0.82	120	90	_	_	4.7	_	_	_	_	_	_	urban
542	63	f	171	79	27	89	101	0.88	140	88	5.1	5.7	_	_	_	_	_	_	_	urban
543	35	f	162	78	29.7	90	108	0.83	126	70	_	_	7.9	_	_	_	_	_	_	urban
544	25	f	154	74	31.2	90	110	0.82	114	72	5	_	_	_	_	_	_	_	_	urban
545	40	f	164	68	25.3	90	104	0.87	130	70	3.7	_	_	_	_	_	_	_	_	urban
546	32	f	174	80	26.4	90	110	0.82	128	78	4.9	_	_	_	_	_	_	_	_	urban
547	25	f	156	72	29.6	90	110	0.82	120	70	5.3	_	_	_	_	_	_	_	_	urban
548	60	f	155	48	20.1	90	97	0.93	138	90	5.7	_	_	_	_	_	_	_	_	urban
549	45	f	165	79	29	90	104	0.87	130	94	_	_	4.1	_	_	_	_	_	_	urban
550	40	f	170	85	29.4	90	100	0.9	126	80	5	_	_	_	_	_	_	_	_	urban
551	33	f	170	68	23.5	92	99	0.93	105	60	5.1	6.3	_	177	44	115	98	1.6	0.363	urban
552	26	f	155	66	27.5	92	108	0.85	140	88	4.9	_	_	_	_	_	_	_	_	urban
553	57	f	169	73	25.6	93	103	0.9	140	60	8.3	_	_	200	74	111	77	102	37.63	urban

554	21	f	163	79	29.7	93	109	0.85	130	80	5	_	_	_	_	_	_	_	_	urban
555	48	f	174	88	29.1	94	92	1.02	150	92	24	_	_	265	28	131	239	5.6	5.899	urban
556	38	f	169	88	30.8	94	97	0.97	150	100	_	_	19	_	_	_	_	_	_	urban
557	40	f	164	74	27.5	94	106	0.89	140	70	3.7	_	_	_	_	_	_	_	_	urban
558	40	f	165	73	26.8	94	105	0.9	138	90	6.6	_	_	_	_	_	_	_	_	urban
559	29	f	162	78	29.7	94	107	0.88	140	90	_	_	4.2	_	_	_	_	_	_	urban
560	55	f	160	82	32	95	109	0.87	144	88	_	_	8.9	_	_	_	_	_	_	urban
561	26	f	166	80	29	96	112	0.86	115	60	_	_	6.3	_	_	_	_	_	_	urban
562	57	f	170	74	25.6	96	100	0.96	128	54	_	_	8.3	_	_	_	_	_	_	urban
563	26	f	166	81	29.4	96	106	0.91	124	84	_	_	6.1	_	_	_	_	_	_	urban
564	21	f	163	81	30.5	96	106	0.91	128	86	4.8	_	_	_	_	_	_	_	_	urban
565	32	f	171	77	26.3	96	107	0.9	134	80	_	_	7.7	_	_	_	_	_	_	urban
566	55	f	160	91	35.5	97	100	0.97	140	90	_	_	9.7	_	_	_	_	_	_	urban
567	60	f	167	79	28.3	97	108	0.9	140	90	_	_	7.3	_	_	_	_	_	_	urban
568	45	f	164	80	29.7	98	104	0.94	130	90	_	_	5	_	_	_	_	_	_	urban
569	64	f	157	75	30.4	98	110	0.89	130	74	_	_	6.3	_	_	_	_	_	_	urban
570	40	f	165	74	27.2	98	115	0.85	133	96	6.7	_	_	_	_	_	_	_	_	urban
571	63	f	169	64	22.4	98	107	0.92	140	88	_	_	5.9	_	_	_	_	_	_	urban
572	57	f	169	70	24.5	98	102	0.96	150	52	_	_	13	_	_	_	_	_	_	urban
573	45	f	164	88	32.7	99	110	0.9	140	90	_	_	5.3	_	_	_	_	_	_	urban
574	30	f	159	82	32.4	100	106	0.94	131	89	_	_	7	_	_	_	_	_	_	urban
575	58	f	168	88	31.2	100	106	0.94	176	88	_	_	17	_	_	_	_	_	_	urban
576	45	f	164	86	32	104	116	0.9	138	90	_	_	5	_	_	_	_	_	_	urban
577	58	f	165	83	30.7	106	105	1.01	180	83	_	_	18	_	_	_	_	_	_	urban
578	60	f	167	82	29.4	107	115	0.93	132	54	_	_	7	_	_	_	_	_	_	urban
579	63	f	169	78	27.3	107	107	1	172	89	5.9	_	_	_	_	_	_	_	_	urban
580	30	f	156	91	37.4	107	125	0.86	145	93	_	_	7.3	_	_	_	_	_	_	urban
581	29	f	162	85	32.4	108	115	0.94	180	110	4	_	_	_	_	_	_	_	_	urban
582	62	f	152	84	36.4	110	115	0.96	136	80	6.4	_	_	_	_	_	_	_	_	urban
583	62	f	152	89	38.5	114	115	0.99	120	80	5.6	_	_	_	_	_	_	_	_	urban
584	25	m	163	51	19.2	62	80	0.77	110	70	_	_	6.6	_	_	_	_	_	_	urban
585	25	m	168	57	20.2	64	84	0.76	120	70	5.1	_	_	_	_	_	_	_	_	urban
586	25	m	168	53	18.9	64	79	0.81	120	70	5.2	_	_	_	_	_	_	_	_	urban
587	25	m	165	55	20.2	66	79	0.84	120	74	5.1	_	_	_	_	_	_	_	_	urban
588	63	m	157	43	17.2	68	77	0.88	140	70	_	_	6.6	_	_	_	_	_		urban
589	22	m	167	57	20.4	70	86	0.81	110	60	5.5	_	_	_	_	_	_	_	_	urban
590	29	m	173	57	19	70	80	0.88	120	80	_	_	5.7	_	_	_	_	_	_	urban
591	46	m	191	70	19.2	71	94	0.76	110	70	_	_	5.7	_	_	_	_	_	_	urban
592	63	m	157	49	19.9	71	85	0.84	130	70	_	_	6.9	_	_	_	_	_	_	urban
593	28	m	165	55	20.2	71	89	0.8	110	70	_	_	6.1	_	_	_	_	_	_	urban
594	62	m	173	60	20	72	80	0.9	137	90	_	_	7.4	_	_	_	_	_	_	urban
595	46	m	170	51	17.5	72	84	0.86	115	80	5.2	6.6	_	172	40	132	118	17	3.929	urban
596	26	m	179	63	19.7	72	90	0.8	112	70	5.1	_	_	_	_	_	_	_	_	urban
597	46	m	161	57	22	72	83	0.87	130	63	_	_	5.2	_	_	_	_	_	_	urban
598	25	m	175	55	18	73	80	0.91	120	80	_	_	4.9	_	_	_	_	_	_	urban
599	25	m	168	56	19.8	73	87	0.84	120	70	_	_	4.7	_	_	_	_	_	_	urban
600	31	m	169	65	22.8	74	78	0.95	130	80	_	_	6.7	_	_	_	_	_	_	urban
601	23	m	173	64	21.5	74	97	0.76	120	80	4.7	5.6	_	169	43	97	112	3.9	0.815	urban
602	40	m	174	60	19.8	74	88	0.84	132	80	4.8	_	_	_	_	_	_	_	_	urban
603	32	m	165	56	20.6	74	88	0.84	128	82	6.6	_	_	_	_	_	_	_	_	urban

604	30	m	166	57	20.7	75	87	0.86	130	90	6.9	11	_	110	50	49	63	61	18.65	urban
605	23	m	187	60	17.2	75	85	0.88	130	80	_	_	6.2	_	_	_	_	_	_	urban
606	29	m	173	60	20	75	89	0.84	120	70	_	_	5.1	_	_	_	_	_	_	urban
607	29	m	173	59	19.7	75	89	0.84	116	78	5.2	5.7	_	182	65	105	58	9.8	2.265	urban
608	62	m	175	59	19.3	76	86	0.88	140	90	_	_	7.9	_	_	_	_	_	_	urban
609	41	m	172	60	20.3	76	91	0.84	134	80	_	_	5.7	_	_	_	_	_	_	urban
610	54	m	174	58	19.2	76	88	0.86	120	70	4.8	_	_	_	_	_	_	_	_	urban
611	18	m	165	65	23.7	76	87	0.87	110	70	5.4	_	_	_	_	_	_	_	_	urban
612	62	m	175	58	18.9	76	84	0.9	170	100	_	_	7.9	_	_	_	_	_	_	urban
613	28	m	184	66	19.3	76	94	0.81	110	80	_	_	5.5	_	_	_	_	_	_	urban
614	40	m	173	60	20	76	87	0.87	130	80	_	_	5.3	_	_	_	_	_	_	urban
615	36	m	167	60	21.3	76	88	0.86	130	80	_	_	6.4	_	_	_	_	_	_	urban
616	29	m	171	60	20.5	77	89	0.87	120	84	5.1	_	_	_	_	_	_	_	_	urban
617	36	m	167	59	21.2	77	89	0.87	130	80	4.2	9.3	_	188	57	94	187	18	3.36	urban
618	40	m	170	60	20.8	77	100	0.77	120	70	_	_	5.3	_	_	_	_	_	_	urban
619	30	m	167	60	21.5	77	86	0.9	130	80	5.3	_	_	_	_	_	_	_	_	urban
620	36	m	168	57	20.2	77	92	0.84	120	85	_	_	6.3	_	_	_	_	_	_	urban
621	18	m	161	56	21.6	77	89	0.87	124	70	4.6	_	_	_	_	_	_	_	_	urban
622	63	m	153	52	22.2	77	82	0.94	126	90	_	_	5.3	_	_	_	_	_	_	urban
623	30	m	168	52	18.4	77	93	0.83	124	72	5.5	_	_	_	_	_	_	_	_	urban
624	54	m	174	56	18.5	77	93	0.83	126	72	4	_	_	_	_	_	_	_	_	urban
625	30	m	169	63	22.1	77	88	0.88	110	70	4.5	_		_	_	_	_	_	_	urban
626	25	m	171	69	23.6	78	90	0.87	110	60	_	_	6.9	_	_	_	_	_	_	urban
627	30	m	168	57	20.2	78	93	0.84	110	70	5.2	_	_	_	_	_	_	_	_	urban
628	36	m	174	59	19.5	78	92	0.85	110	70	4.3	5.6	_	176	50	111	71	14	2.695	urban
629	34	m	155	47	19.4	78	85	0.92	125	89	5.5	_		_	_	_	_	_	_	urban
630	21	m	172	74	24.8	78	96	0.81	130	70	_	_	7.6	_	_	_	_	_	_	urban
631	22	m	167	58	20.8	78	93	0.84	120	70	5.2	_	_	_	_	_	_	_	_	urban
632	25	m	173	69	23	78	90	0.87	110	60	_	_	6.3	_	_	_	_	_	_	urban
633	34	m	155	51	21.2	78	88	0.89	120	80	4.2	_	_	_	_	_	_	_	_	urban
634	57	m	169	67	23.5	79	90	0.88	132	88	4	4.9		171	48	103	97	9.8	1.742	urban
635	46	m	170	55	19	79	96	0.82	120	72	5.1	_	_	_	_	_	_	_	_	urban
636	36	m	167	61	21.9	79	88	0.9	130	80	_	_	6.3	_	_	_	_	_	_	urban
637	18	m	165	63	23.1	79	94	0.84	120	70	5.3	5.9	_	147	34	101	65	9.8	2.308	urban
638	36	m	174	58	19.2	79	99	0.8	128	76	5	6.5	_	147	67	70	52	6.7	1.489	urban
639	30	m	168	62	22	80	89	0.9	110	70	_	_	5.6	_	_	_	_	_	_	urban
640	26	m	154	60	25.3	80	105	0.76	120	70	4.9		_	_	_	_	_	_	_	urban
641	46	m	168	69	24.4	80	97	0.82	120	70	5.3	_	_	_	_	_	_	_	_	urban
642	30	m	169	65	22.8	80	97	0.82	124	75	5.2	_	_	_	_	_	_	_	_	urban
643	55	m	173	68	22.7	80	92	0.87	130	80	5.2	_	_	_	_	_	_	_	_	urban
644	26	m	179	70	21.8	80	97	0.82	120	70	5.3	5.4	_	147	46	82	90	5.4	1.272	urban
645	61	m	176	67	21.6	80	99	0.81	130	78	4.6	_	_	_	_	_	_	_	_	urban
646	25	m	173	67	22.4	80	95	0.84	110	60	_	_	6.3	_	_	_	_	_	_	urban
647	40	m	179	64	20	80	93	0.86	110	90	_	_	7.3	_	_	_	_	_	_	urban
648	25	m	175	57	18.6	80	89	0.9	126	78	_	_	5.1	_	_	_	_	_	_	urban
649	25	m	163	55	20.7	80	97	0.82	124	80		_	6.1	_	_	_	_	_	_	urban
650	30	m	167	61	21.9	80	97	0.82	120	78	5.3	_	_	_	_	_	_	_	_	urban
651	25	m	168	61	21.6	80	97	0.82	124	80	_	_	6	_	_	_	_	_	_	urban
652	59	m	162	52	19.8	80	96	0.83	134	86	_	_	8.2	_	_	_	_	_	_	urban
653	27	m	168	64	22.7	81	88	0.92	120	70	_	_	6.3	_	_	_	_	_	_	urban

654	31	m	166	61	22.1	81	87	0.93	130	80	_	_	7.5	_	_	_	_	_	_	urban
655	57	m	173	68	22.6	81	91	0.89	130	80	5.4	_	_	_	_	_	_	_	_	urban
656	32	m	169	66	23.1	81	96	0.84	120	70	_	_	7	_	_	_	_	_	_	urban
657	59	m	174	66	21.8	81	93	0.87	140	90	_	_	5.4	_	_	_	_	_	_	urban
658	23	m	168	64	22.7	81	95	0.85	124	70	4.5	_	_	_	_	_	_	_	_	urban
659	55	m	172	69	23.3	82	92	0.89	132	80	_	_	5.8							urban
660	25	m	177	70	22.3	82	93	0.88	110	80	4.2	_	_	_	_	_	_	_	_	urban
661	59	m	168	68	24.1	82	96	0.85	138	88	4.9	_	_	_	_	_	_	_	_	urban
662	40	m	174	63	20.8	82	98	0.84	134	78	5.5	6.6	_	145	54	112	124	19	4.669	urban
663	55	m	174	68	22.5	82	84	0.98	130	84	_	_	4.9	_	_	_	_	_	_	urban
664	55	m	168	60	21.3	83	86	0.97	190	110	4.1	5.3	_	159	40	88	155	21	3.827	urban
665	61	m	176	66	21.3	83	97	0.86	126	88	4.3	_	_	_	_	_	_	_	_	urban
666	25	m	168	65	23	83	97	0.86	124	80	_	_	6.3	_	_	_	_	_	_	urban
667	64	m	171	65	22.2	83	99	0.84	132	80	5.1	_	_	_	_	_	_	_	_	urban
668	33	m	169	66	23.1	83	95	0.87	120	82	5.4	_	_	_	_	_	_	_	_	urban
669	46	m	191	81	22.2	83	107	0.78	124	76	_	_	6	_	_	_	_	_	_	urban
670	62	m	176	62	20	83	92	0.9	133	87	4.1	_	_	_	_	_	_	_	_	urban
671	65	m	167	58	20.8	84	96	0.88	124	70	_	_	8.4	_	_	_	_	_	_	urban
672	40	m	154	62	26.1	84	96	0.88	140	70	_	_	7.6	_	_	_	_	_	_	urban
673	62	m	173	63	21	84	96	0.88	137	87	4.9	5.7	_	127	46	79	67	28	6.098	urban
674	54	m	176	64	20.7	84	94	0.89	130	90	_	_	7.4	_	_	_	_	_	_	urban
675	25	m	166	58	21	84	90	0.93	110	70	_	_	6.1	_	_	_	_	_	_	urban
676	62	m	175	61	19.9	84	99	0.85	140	90	_	_	8.1	_	_	_	_	_	_	urban
677	38	m	167	75	26.7	85	98	0.87	120	80	_	_	7.2	_	_	_	_	_	_	urban
678	40	m	179	67	20.9	85	97	0.88	120	80	_	_	7.1	_	_	_	_	_	_	urban
679	21	m	172	75	25.4	85	105	0.81	124	72	_	_	7.7	_	_	_	_	_	_	urban
680	55	m	164	60	22.3	85	93	0.91	140	88	5.4	7.9	_	191	71	102	90	83	19.92	urban
681	25	m	173	69	23.1	85	95	0.89	110	80	_	_	6.9	_	_	_	_	_	_	urban
682	27	m	168	65	23	85	98	0.87	124	80	_	_	6.1	_	_	_	_	_	_	urban
683	46	m	168	66	23.4	85	97	0.88	134	84	5.3	_	_	_	_	_	_	_	_	urban
684	62	m	176	60	19.4	85	99	0.86	132	80	5.4	_	_	_	_	_	_	_	_	urban
685	31	m	166	63	22.9	85	94	0.9	126	82	_	_	7	_	_	_	_	_	_	urban
686	40	m	170	62	21.5	85	106	0.8	132	72	_	_	4.9	_	_	_	_	_	_	urban
687	55	m	163	60	22.6	85	93	0.91	140	79	5.8	_	_	_	_	_	_	_	_	urban
688	25	m	177	68	21.7	85	97	0.88	120	78	4.1	_	_	_	_	_	_	_	_	urban
689	25	m	177	72	23	86	99	0.87	116	84	4.2	4.9		159	46	101	110	5.9	1.101	urban
690	58	m	177	69	22	86	97	0.89	150	98	6.8	_	_	239	40	78	191	46	13.9	urban
691	37	m	176	82	26.5	86	96	0.9	128	84	_	_	5.6	_	_	_	_	_	_	urban
692	58	m	178	69	21.9	86	94	0.91	135	87	6.5	_	_	_	_	_	_	_	_	urban
693	64	m	170	72	24.9	87	98	0.89	140	88	4.7	_	_	_	_	_	_	_	_	urban
694	59	m	174	72	23.8	87	103	0.84	130	86	4.5	5.9	_	147	42	80	123	18	3.56	urban
695	28	m	176	70	22.6	87	99	0.88	120	80	_	_	5.2	_	_	_	_	_	_	urban
696	33	m	168	68	24.1	87	99	0.88	124	80	_	_	4.8	_	_	_	_	_	_	urban
697	58	m	171	73	25	87	97	0.9	124	86	5.5	_	_	_	_	_	_	_	_	urban
698	57	m	168	63	22.3	87	96	0.91	120	90	4	_	_	_	_	_	_	_	_	urban
699	30	m	167	68	24.4	87	97	0.9	130	82	4.8	_	_	_	_	_	_	_	_	urban
700	38	m	167	72	25.8	87	102	0.85	110	80	_	_	7.6	_	_	_	_	_	_	urban
701	27	m	167	76	27.3	87	92	0.95	130	80	_	_	4.8	_	_	_	_	_	_	urban
702	53	m	163	64	24.1	88	94	0.94	138	90	5	_	_	_	_	_	_	_	_	urban
703	58	m	178	70	22.1	88	98	0.9	150	96	6.8	_	_	_	_	_	_	_	_	urban

704	65	m	169	65	22.8	88	104	0.85	124	88	4.7	_	_	_	_	_	_	_	_	urban
705	36	m	160	60	23.4	88	105	0.84	126	82	4.2	_	_	_	_	_	_	_	_	urban
706	29	m	168	74	26.2	88	97	0.91	134	82	5.1	_	_	_	_	_	_	_	_	urban
707	49	m	170	88	30.4	88	102	0.86	140	89	_	_	8	_	_	_	_	_	_	urban
708	29	m	177	76	24.3	88	106	0.83	124	82	4.3	_	_	_	_	_	_	_	_	urban
709	53	m	164	61	22.7	88	86	1.02	130	80	4.8	_	_	_	_	_	_	_	_	urban
710	24	m	187	70	20	88	97	0.91	136	84	_	_	6.7	_	_	_	_	_	_	urban
711	33	m	168	73	25.9	88	103	0.85	124	76	4	_	_	_	_	_	_	_	_	urban
712	46	m	169	67	23.5	88	108	0.81	128	80	_	_	6.9	_	_	_	_	_	_	urban
713	25	m	166	59	21.4	88	95	0.93	120	70	_	_	5.7	_	_	_	_	_	_	urban
714	30	m	167	69	24.7	88	92	0.96	120	70	5.3	7.9	_	177	37	87	99	22	5.276	urban
715	46	m	168	69	24.4	88	89	0.99	130	90	4.9	_	_	_	_	_	_	_	_	urban
716	33	m	168	71	25.2	88	96	0.92	130	80	_	_	5.1	_	_	_	_	_	_	urban
717	27	m	167	75	26.9	89	94	0.95	126	80	4.9	_	_	_	_	_	_	_	_	urban
718	32	m	167	72	25.8	89	100	0.89	120	80	5.5	_	_	_	_	_	_	_	_	urban
719	35	m	162	59	22.5	89	98	0.91	128	72	_	_	6.2	_	_	_	_	_	_	urban
720	27	m	167	75	26.9	89	105	0.85	128	82	4.9	_	_	_	_	_	_	_	_	urban
721	46	m	168	67	23.7	89	106	0.84	120	78	5.2	_	_	_	_	_	_	_	_	urban
722	65	m	168	77	27.3	89	100	0.89	132	84	4.6	_	_	_	_	_	_	_	_	urban
723	46	m	171	80	27.4	89	105	0.85	140	90	_	_	7.2	_	_	_	_	_	_	urban
724	62	m	176	70	22.6	89	107	0.83	130	86	4.9	_		_	_	_	_	_	_	urban
725	27	m	167	79	28.3	89	100	0.89	126	82	5.1	_	_	_	_	_	_	_	_	urban
726	54	m	176	67	21.6	89	105	0.85	136	78	_	_	7.1	_	_	_	_	_	_	urban
727	29	m	168	73	25.9	89	103	0.86	132	84	5.3	_	_	_	_	_	_	_	_	urban
728	64	m	171	72	24.6	89	106	0.84	134	85	5.3	_		_	_	_	_	_	_	urban
729	33	m	169	74	25.9	90	97	0.93	130	90	4.8	_	_	_	_	_	_	_	_	urban
730	50	m	167	70	25.1	90	103	0.87	130	90	_	_	6.1	_	_	_	_	_	_	urban
731	30	m	167	72	25.8	90	99	0.91	130	77	5.5	_	_	_	_	_	_	_	_	urban
732	40	m	156	59	24.2	90	96	0.94	129	74	_	_	7.6	_	_	_	_	_	_	urban
733	48	m	184	91	26.9	90	102	0.88	140	90	5.6	_	_	_	_	_	_	_	_	urban
734	65	m	168	78	27.6	90	99	0.91	140	86	4.7	5.3	_	182	50	114	92	6	1.253	urban
735	40	m	153	58	24.8	90	96	0.94	140	74	_	_	7.7	_	_	_	_	_	_	urban
736	50	m	167	71	25.3	90	103	0.87	130	90	_	_	6	_	_	_	_	_	_	urban
737	55	m	171	73	25	91	99	0.92	140	90	_	_	20	_	_	_	_	_	_	urban
738	24	m	171	70	23.9	91	103	0.88	110	62	_	_	4.7	_	_	_	_	_	_	urban
739	61	m	167	78	28	91	103	0.88	148	92	10	_	_	_	_	_	_	_	_	urban
740	48	m	175	67	21.9	91	99	0.92	139	84	_	_	9.3	_	_	_	_	_	_	urban
741	46	m	164	75	27.9	91	101	0.9	152	96	_	_	9.7	_	_	_	_	_	_	urban
742	38	m	177	80	25.7	91	90	1.01	130	100	_	_	5.7	_	_	_	_	_	_	urban
743	58	m	169	72	25.2	92	95	0.97	140	90	_	_	22	_	_	_	_	_	_	urban
744	45	m	179	85	26.5	92	99	0.93	133	90	5.6	_	_	_	_	_	_	_	_	urban
745	49	m	184	87	25.7	92	107	0.86	132	84	6.8	_	_	_	_	_	_	_	_	urban
746	55	m	168	73	25.9	92	95	0.97	140	88	5.2	_	_	_	_	_	_	_	_	urban
747	40	m	155	58	24.1	92	98	0.94	138	72	_	_	7.7	_	_	_	_	_	_	urban
748	55	m	169	75	26.3	93	105	0.89	136	88	_	_	15	_	_	_	_	_	_	urban
749	62	m	172	88	29.7	93	107	0.87	138	84	5	_	_	_	_	_	_	_	_	urban
750	49	m	170	78	27	94	99	0.95	160	90	6.7	10	_	252	27	179	226	19	5.688	urban
751	49	m	171	88	30.1	94	107	0.88	140	90	_	_	8	_	_	_	_	_	_	urban
752	58	m	175	74	24.2	94	103	0.91	150	90	6.7	_	_	_	_	_	_	_	_	urban
753	38	m	177	80	25.5	94	92	1.02	134	86	_	_	5.6	_	_	_	_	_	_	urban

754	44	m	176	90	29.1	94	106	0.89	120	90	5.3	_	_	_	_	_	_	_	_	urban
755	47	m	173	72	24.1	95	99	0.96	156	98	_	_	19	_	_	_	_	_	_	urban
756	60	m	169	80	28	95	104	0.91	140	94	_	_	9.6	_	_	_	_	_	_	urban
757	42	m	170	79	27.3	95	105	0.9	138	86	_	_	8.7	_	_	_	_	_	_	urban
758	65	m	168	75	26.6	95	97	0.98	124	88	4.3	_	_	_	_	_	_	_	_	urban
759	49	m	180	96	29.6	96	102	0.94	137	90	6.6	_	_	_	_	_	_	_	_	urban
760	45	m	182	85	25.7	96	106	0.91	140	90	4.5	6.7		159	55	24	155	14	2.82	urban
761	34	m	184	89	26.3	96	103	0.93	120	90	5.5	_	_	_	_	_	_	_	_	urban
762	55	m	175	82	26.8	96	99	0.97	126	86	6.9	_	_	_	_	_	_	_	_	urban
763	58	m	175	71	23	96	103	0.93	130	90	6.3	_	_	_	_	_	_	_	_	urban
764	48	m	176	63	20.3	96	92	1.04	150	100	_	_	12	_	_	_	_	_	_	urban
765	35	m	162	61	23.2	97	99	0.98	120	70	_	_	6.7	_	_	_	_	_	_	urban
766	60	m	167	78	28	98	102	0.96	136	90	_	_	9.9	_	_	_	_	_	_	urban
767	49	m	184	100	29.5	98	101	0.97	150	90	6.6	12	_	206	42	145	97	156	45.76	urban
768	47	m	170	93	32.2	99	102	0.97	150	110	_	_	8.9	_	_	_	_	_	_	urban
769	61	m	166	78	28.3	100	102	0.98	140	90	_	_	9.4	_	_	_	_	_	_	urban
770	43	m	161	83	32	101	99	1.02	160	100	_	_	8.9	_	_	_	_	_	_	urban
771	53	m	172	97	32.8	102	108	0.94	164	112	6.5	_	_	_	_	_	_	_	_	urban
772	60	m	167	77	27.6	103	111	0.93	190	112	13	_	_	429	44	367	90	36	21.19	urban
773	54	m	180	82	25.3	104	100	1.04	130	80	17	_	_	_	_	_	_	_	_	urban
774	60	m	167	80	28.7	106	108	0.98	180	100	11	_	_	_	_	_	_	_	_	urban
775	37	m	177	90	28.7	108	112	0.96	160	90	5.9	_	_	_	_	_	_	_	_	urban
776	51	m	175	81	26.3	111	108	1.03	150	90		_	8.7	_	_	_	_	_	_	urban
777	42	m	170	96	33.2	114	110	1.04	190	110	_	_	9.3	_	_	_	_	_	_	urban
778	51	m	166	109	39.6	119	121	0.98	167	76	_	_	8.3	_	_	_	_	_	_	urban
779	62	m	172	103	34.8	119	112	1.06	150	80	6.3	_	_	_	_	_	_	_	_	urban
780	46	m	176	124	40	119	122	0.98	142	92	6.4	7.5	_	229	36	161	161	36	10.24	urban
781	51	m	166	111	40.3	120	122	0.98	170	70	_	_	8.3	_	_	_	_	_	_	urban
782	45	m	176	122	39.4	127	122	1.04	150	94	6.9	_	_	_	_	_	_	_	_	urban

761	34	m	184	89	26.29	96	103	0.932	120	90	5.5	_	_	_	_
762	55	m	175	82	26.78	96	99	0.97	126	86	6.9	_	_	_	_
763	58	m	175	70.5	23.02	96	103	0.932	130	90	6.3	_	_	_	_
764	48	m	176	63	20.34	96	92	1.043	150	100	_	_	11.7	_	_
765	35	m	162	61	23.24	97	99	0.98	120	70	_	_	6.7	_	_
766	60	m	167	78	27.97	98	102	0.961	136	90	_	_	9.9	_	_
767	49	m	184	100	29.54	98	101	0.97	150	90	6.6	12.3	_	206	42
768	47	m	170	93	32.18	99	102	0.971	150	110	_	_	8.9	_	_
769	61	m	166	78	28.31	100	102	0.98	140	90	_	_	9.4	_	_
770	43	m	161	83	32.02	101	99	1.02	160	100	_	_	8.9	_	_
771	53	m	172	97	32.79	102	108	0.944	164	112	6.5	_	_	_	_
772	60	m	167	77	27.61	103	111	0.928	190	112	13.1	_	_	429	44.1
773	54	m	180	82	25.31	104	100	1.04	130	80	16.8	_	_	_	_
774	60	m	167	80	28.69	106	108	0.981	180	100	11.2	_	_	_	_
775	37	m	177	90	28.73	108	112	0.964	160	90	5.9	_	_	_	_
776	51	m	175	80.5	26.29	111	108	1.028	150	90		_	8.7	_	_
777	42	m	170	96	33.22	114	110	1.036	190	110	_	_	9.3	_	_
778	51	m	166	109	39.56	119	121	0.983	167	76	_	_	8.3	_	_
779	62	m	172	103	34.82	119	112	1.063	150	80	6.3	_	_	_	_
780	46	m	176	124	40.03	119	122	0.975	142	92	6.4	7.5	_	229	35.7
781	51	m	166	111	40.28	120	122	0.984	170	70	_	_	8.3	_	_
782	45	m	176	122	39.39	127	122	1.041	150	94	6.9	_	_	_	_