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Food security and dietary diversity: The case study of Arba Minch Zuriya district, Gamo zone, SNNPR, Ethiopia

MASTER'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled “Food security and dietary diversity: The case study of Arba Minch Zuriya district, Gamo zone, SNNPR, Ethiopia” independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague, 24th April 2024

.....

Sára Šebrlová

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Abstract

This research was conducted in the Arba Minch Zuriya district, Gamo zone, SNNPR, Ethiopia, aimed to assess dietary diversity, caloric intake, and associated factors among women of reproductive age (WRA). A Women Dietary Diversity Score (WDDS) was obtained from 145 women, while caloric intake data were collected from 47 women through a 24-Hour Dietary Recall Survey (24HR). Additionally, a Focus Group Discussion (FGD) involving six women was conducted to gain qualitative insights. Socioeconomic and demographic characteristics were determined. The average WDDS of respondents was below the recommended minimum for women, revealing the consumption of 3.9 food groups, with starchy staple foods, dark green leafy vegetables, and other fruits and vegetables being prominent. The most commonly consumed foods included kitcha, fossese, kurkufa, and injera. The average caloric intake was 1,345 kcal per day, falling below the recommended limit of 2,000 kcal per day. During the FGDs, insufficient feeding of women participants was attributed mainly to financial constraints limiting the purchase of a more diversified range of foods. Binary logistic regression indicated the significance of variables such as the number of information sources, age, number of livestock in the household, and marital status in influencing the WDDS of respondents.

Key words: women, nutrients, dietary components, food insecurity, Women dietary diversity score

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List of the abbreviations used in the thesis

WRA	Women of reproductive age
24HR	24-hour Dietary Recall
CVD	Cardiovascular diseases
DDS	Dietary Diversity Score
DM	Diabetes mellitus
ETB	Ethiopian birr
FAO	Food and Agriculture Organization
FFQs	Food-Frequency Questionnaires
FGD	Focus group discussions
HH	Household
IPC	Integrated Food Security Phase Classification
Kcal	Kalorific
PEM	Protein-energy malnutrition
SNNPRS	Southern Nation, Nationalities and People Regional State
T2DM	Type 2 diabetes mellitus
US	United States
USD	United States dollar
VAD	Vitamin A deficiency
WDDS	Women Dietary Diversity Score
WHO	World Health Organization

1. Introduction

Human nutrition is one of the important environmental factors that affect human health. The way we eat is an integral part of our lifestyle and can have consequences for all areas of our lives. Food and fluids are essential for maintaining good health as they can supply our body with all the substances it needs. Incorrect, insufficient or excessive nutrition deteriorates our health (Hrnčířová et al. 2012). A healthy diet helps protect against malnutrition and diet-related noncommunicable diseases such as heart disease, diabetes, stroke, and cancer (Shogo et al. 2021). In addition to the basic nutrients (macronutrients) - protein, fat, and carbohydrates, food also contains a number of other nutrients (micronutrients) which are important to human beings. These include vitamins, minerals, trace elements, fibres, and many others. Macronutrients should be supplied to the body in a certain ratio, which is called the triple ratio of nutrients. Of the total amount of energy intake per person, 15 percent should come from protein, 30 percent from fat, and 55 percent from carbohydrates (Hrnčířová et al. 2012).

Meals should be consumed during the day at regular intervals, preferably more frequently and in small portions. Irregularity leads to imperceptible overeating, obesity, fatigue, and reduced performance. From a health point of view, it is recommended that the daily ration of food be divided into five or six meals (approximately three-hour breaks between meals). Regular diet provides the body with substances necessary for its activity - nutrients. Nutrients are processed in the body and used as a source of energy, used to build tissues or to produce all substances necessary for its activity (Hrnčířová & Marádová 2018).

Along with regular intake, the diet should also be diversified. The impact of dietary diversity on nutrient and vitamin intake is one of the most crucial components of a healthy diet. Greater variety in the daily diet is associated with a greater intake of macro- and micronutrients (Mahdavi-Roshan et al. 2021). Lack of dietary diversity is a particularly serious problem for poor populations in countries because their diets are based largely on starchy foods and often contain little or no animal products and few fresh fruits and vegetables. These diets based on plants tend to be low in the number of micronutrients, and the micronutrients they contain are often in a form that is not easily absorbed (Ruel 2003). Every day, the human diet should contain sufficient amounts of

vegetables and fruits, legumes (e.g. lentils, beans), nuts, and whole grains (e.g. unprocessed millet, wheat, oats, maise, brown rice) (Shogo et al. 2021).

In countries of the Global South, women of reproductive age (WRA) (15-49 years), along with infants, young children, and adolescent women, are particularly at risk of deficiencies of essential micro and macro nutrients (Puwanant et al. 2022). In 2022, among women of reproductive age, 19 percent were underweighted, and two out of three were deficient in one or more micronutrients (CGIAR 2023). Women of reproductive age are often nutritionally vulnerable due to the physiological demands of pregnancy and breastfeeding. The requirements for most nutrients are even higher in pregnant and lactating women than in adult men. Inadequate nutrient intake before and during pregnancy and lactation can affect women, especially their children. A woman's nutritional and health status before and/or during pregnancy affects not only the physiological adaptation to pregnancy but also the periconceptional environment for the embryo and, ultimately, the environment of the fetus. Periconceptional problems such as low maternal weight before pregnancy, severe iodine deficiency and folate deficiency negatively affect pregnancy outcomes. For example, vitamin A deficiency can lead to preterm birth, iron deficiency to fetal growth restriction, and folate deficiency to neural tube defect (Puwanant et al. 2022; Nkoko et al. 2023). Although it is known that in many developing countries, the quality of diets, and not only in the case of WRA, is still very poor, and there are gaps between requirements and actual intakes of micro- and macronutrients, the situation is not improving today (USAID & SPRING 2015; FANTA 2016).

1.1. Micro and macro nutrients

As mentioned above, there are basically two most important classes in nutrition: macronutrients and micronutrients. Macronutrients can be considered the main components of various tissues and represent the total amount of calories taken in, which are the main energy source for the human body. We distinguish mainly carbohydrates, proteins and lipids. On the other hand, micronutrients are those components of the diet that do not provide a significant proportion of the calories consumed but can nevertheless be considered essential for health and vital functions, even if they are needed in smaller

quantities. These include mainly vitamins, minerals and trace elements (Savarino et al. 2021).

1.1.1. Macronutrients

1.1.1.1. Fats

Fats are the biggest source of energy for our body. They are involved in the metabolism of fat-soluble vitamins and play an important role in regulating body temperature. Some of them are sources of essential fatty acids that the body cannot produce on its own. Fats have a high energy value - one gram of fat provides the body with approximately 38 kJ, which is twice as much as carbohydrates and protein (Hrnčířová et al. 2012).

Fats are subdivided into unsaturated fats, which consist mainly of unsaturated fatty acids. Unsaturated fatty acids positively impact human health, especially for the proper functioning of the brain and sex glands. The next are saturated fats, composed mainly of saturated fatty acids. Their excess in the diet has negative health effects compared to unsaturated fatty acids as they increase cholesterol levels, increasing the risk of cardiovascular disease and cancer. The last are trans unsaturated fats, which have a negative effect on human health, even worse than saturated fats (Wanless & Judge 2010).

Unsaturated fatty acids are mainly found in vegetable oils, fish, avocados and nuts. In addition, saturated fats are primarily found in animal fat-containing foods (except fish oil) and in some foods of plant origin (e.g. coconut, palm kernel and palm oil). In particular, we should avoid lard, fatty meats, sausages, pate, and excessive consumption of butter and cream products because of their high cholesterol content. Last but not least, food products made with confectionery and bakery fats are a source of trans-fatty acids (Hrnčířová et al. 2012).

1.1.1.2. Proteins

Proteins are the keystone of all living organisms on Earth. In the human body, they are found in many different forms in all tissues and have many different functions – structural (proteins in connective tissues and muscles, organs, and bone, e.g. collagen), enzymatic (e.g. digestive enzyme trypsin, which cleaves proteins in food), hormonal (e.g. known hormone insulin regulating blood glucose level), and transport (e.g. hemoglobin-

the main protein of red blood cells which transport oxygen from lungs to tissues and back in the form of CO_2) (Hume 2005; Roubík 2018).

Proteins are essential for the origin and maintenance of life because they are the only source of nitrogen in the human diet and the only source of essential amino acids. Although proteins can be used as a source of energy, they are primarily used in the form of building substances for enzyme synthesis, hormones, regeneration of connective tissues, and more. If the diet is relatively well-balanced and contains enough carbohydrates and fats, only 20 percent of protein intake is decomposed in the organism to energy and the rest is preserved in body structure and tissues in the form of amino acids (Roubík 2018).

Protein is commonly found in animal tissues and their products (e.g. meat, eggs, and dairy products) and in vegetables such as cereals and legumes (Underwood & Galal 2011).

1.1.1.3. Carbohydrates

Carbohydrates are one of the main components of living organisms and the most widely used organic matter on the planet at the same time. For the human body, carbohydrates are the main energy intake. Carbohydrates are cleft and transported by metabolic processes to glucose. D-glucose is a nutrient for every human body cell and, for some of them, is a prevalent or exclusive energy intake (e.g. brain, red blood cells, bollock, retina, bone marrow and more). Carbohydrates are the only type of nutrients that are not essential for the human body, and one cannot depend on them alone because if they are deficient, vital organs and tissues would stop working. Because of this, humans have several mechanisms to create carbohydrates and glucose from protein and fats in the event of insufficient amounts in the diet, which is less efficient and unsustainable for the body in the long term. Another important and related function of carbohydrates is energy storage in the body. In addition, carbohydrates have a number of other crucial functions, for example, structural, together with proteins, they form so-called glycoproteins, which are, among other things, the basic component of cartilaginous tissues and joints and together with glycolipids, which are essential components of all cell membranes in the organism (Roubík 2018).

According to the number of sugar units, carbohydrates are divided into three basic groups - monosaccharides, oligosaccharides, and polysaccharides. Monosaccharides contain one sugar unit and include, for example, glucose (grape sugar) and fructose (fruit sugar). Oligosaccharides contain 2-10 identical or different monosaccharides, and examples are sucrose (beet and cane sugar) consists of glucose and fructose, lactose (milk sugar) consists of glucose and galactose, the carbohydrates in legumes (raffinose, stachyose, verbascose, etc.) contain galactose and others. Polysaccharides contain more than ten monosaccharides - starch, cellulose, pectin, inulin, etc. (Hume 2005; Roubík 2018).

The most common simple carbohydrate (sugar) is sucrose. It is made from sugar beet or sugar cane and is usually called sugar. Carbohydrates are found in tabletop sweeteners and are added to many food products - baked goods, cereals, confectionery, chocolate, ice cream, sweetened beverages, etc. (Harter 2022).

Lactose is found in milk and dairy products. Glucose is found in syrups, fruits, and honey. Fructose is found in the same foods but in different amounts. Polysaccharide is a major component of cereals, cereal products, legumes, and potatoes. Indigestible polysaccharide (fibre) is found in fruits, vegetables, legumes, mushrooms, cereals, and products made from dark and wholemeal flours (Hume 2005).

1.1.1.4. Dietary fibre

Dietary fibre is a mixture of indigestible substances that our body cannot break down. It is contained in various parts of plants and their fruits. Fibre can be divided into water-soluble and water-insoluble. Water-soluble fibre plays an important role in the prevention of cardiovascular disease as it reduces elevated cholesterol and fat levels in the blood. It is also involved in protecting against colon cancer, internal haemorrhoids, intestinal diverticulosis or in regulating stool consistency. As a dietary supplement, it is used in diets to treat obesity because it prolongs the feeling of satiety (Barber et al. 2020).

Fibre can be found in whole grain cereals, vegetables, fruits, legumes and nuts. Insoluble fibre is more likely to be found in the skins of apples, pears, grapes or potatoes, as well as in cereals, wholemeal bread and oatmeal. Soluble fibre is found in larger amounts in citrus fruits, bananas, apples, pears and also in carrots, kale, beans, flaxseed and rose hips (Hrnčířová et al. 2012).

1.1.2. Micronutrients

1.1.2.1. Vitamins

Vitamins are organic substances essential for the regulation of metabolic functions in cells and for the processes that release energy from food. Vitamins are not produced by the human body, however, they are essential for normal bodily functions. Their deficiency in the diet leads to the characteristic and now well-defined manifestations of many diseases, and the addition of these substances to the diet results in the elimination of the disease and its symptoms (Kladenský 2017).

There are two main classes of vitamins: fat-soluble and water-soluble. Fat-soluble vitamins A (and carotenoids of provitamin A), E, D, and K require proteins or other water-miscible carriers for transport, are not easily excreted and are stored in body tissues in excess. The water-soluble vitamins are the B vitamins - thiamine (B1), riboflavin (B2), niacin, folate, pyridoxine (B6), cyanocobalamin (B12), pantothenic acid, and vitamin C. These vitamins are easily transported and excreted and accumulate in the body tissues only to a limited extent, i.e. they should be consumed almost daily to ensure their need (Underwood & Galal 2011).

Fat-soluble vitamins

Vitamin A (Retinol)

Vitamin A is a micronutrient important for the development and growth of the human body. It is essential for eye health, vision, and proper immune system (Busse et al. 2017). Vitamin A is present in dairy products (milk, butter, cheese, ice cream), eggs, liver, and other internal organs (kidney, heart), as well as many fish (sardines, tuna). Green leafy vegetables and carrots are also sources of vitamin A; on the other hand, cereal grains contain a very small amount of this vitamin (Robert et al. 2001).

Vitamin D

Vitamin D is essential for proper skeletal structure and function. Reduced vitamin D intake plays a role in immunity disorders and cardiovascular and cancer diseases (Hrdý & Novosad 2015). Vitamin D also regulates calcium and phosphorus metabolism. The body is able to self-produce vitamin D, namely, in the skin, with the participation of UV

radiation. The sources of vitamin D are mainly foods of animal origin. (liver, fish liver oil, egg yolk) (Fajfrová 2011).

Vitamin E

Vitamin E is essential for normal cell metabolism. Its function is to protect cells from the harmful effects of free oxygen radicals (it provides protection of cells from oxidative damage) (Kladenský 2017). Sources of this vitamin include wheat germ oil, nuts, cereals, meat, eggs, milk, green leafy vegetables, and other vegetables (Akram et al. 2020).

Vitamin K

This vitamin is essential for the proper function of the blood clotting process (Kladenský 2017). Sources of this vitamin are green plants and algae (spinach, broccoli, legumes), liver, eggs, meat, and milk. Another source is the production of vitamin K by the activity of the intestinal microflora (Fajfrová 2011).

Water-soluble vitamins

Vitamin B1 (thiamine)

Thiamine is one of the key members of the B vitamin group, also referred to as vitamin B1, because it was the first vitamin of this group to be discovered (Kladenský 2017). The body's main functions include involvement in carbohydrate metabolism and proper nerve function (Roubík 2018). The classic manifestation of thiamine deficiency is the development of beri-beri disease, which is manifested by inappetence, muscle weakness, decreased reflexes, and shortness of breath and can lead to heart failure (Fajfrová & Pavlík 2013). We can find thiamine in nuts, meat, potatoes, beans, and cereals (Akram et al. 2020).

Vitamin B2 (riboflavin)

Vitamin B2 belongs to the group of flavins (hence the name riboflavin). Flavins are an essential part of the enzymes that carry out oxidation-reduction reactions in cells (cell respiration) and thus help provide the energy needs of the body’s organs (Kladenský 2017). Riboflavin is found in dairy products and verdant green vegetables (Kladenský 2017 & Akram et al. 2020).

Vitamin B3 (niacin)

Niacin deficiency manifests as pellagra (rough skin) (Fajfrová & Pavlík 2013), dementia, and diarrhoea (Roubík 2018). The main sources of niacin are meat, tripe, fish, whole grain products, potatoes, and legumes (Kladenský 2017).

Vitamin B5 (pantothenic acid)

Pantothenic acid plays a key role in metabolism by producing one of the most crucial and widespread factors in metabolism, coenzyme A. Therefore, it interferes in a fundamental way in the metabolism of sugars, fats, and amino acids (Kladenský 2017). Symptoms of deficiency include fatigue and weakness, muscle cramps and hand tremors, neurological problems, and sleep disturbances. Dietary sources include meat, fish, yeast, cereals, legumes, eggs, and liver (Roubík 2018).

Vitamin B6 (pyridoxine)

Pyridoxine is one of the most important vitamins ever. It is involved in the modulation of protein structure, especially the steroid hormone receptor and haemoglobin. Vitamin B6 deficiency is manifested by weakness, insomnia, inflammatory symptoms in the mucous membranes of the oral region, impaired cellular immunity and increased incidence of infections. Vitamin B6 is widely distributed in the diet, and it is most abundant in meat and whole-grain foods (Kladenský 2017).

Vitamin B7 (biotin)

Biotin helps in fatty acid synthesis, glucose utilisation, protein metabolism, and the utilisation of vitamin B12 and folic acid (Akram et al. 2020). Its deficiency symptoms include fatigue, muscle pain, muscle weakness, mental anorexia, dermatitis, and depression. The main dietary sources are egg yolk, milk, yeast, soy, legumes, liver, leafy vegetables, and peanuts (Roubík 2018).

Vitamin B9 (folic acid)

Vitamin B9, folic acid or folate, is a water-soluble vitamin. Folate is the collective name for various compounds that have the effect of vitamin B9 and are naturally present in foods. The term "folic acid" refers to a synthetic form of this B vitamin, which is used, for example, in dietary supplements or vitamin-fortified foods. Vitamin B9 is involved in various processes such as cell division, cell formation and regeneration, and blood formation. Various vegetables are good sources of folic acid, especially green leafy

vegetables such as spinach and lettuce, as well as cabbage, fennel, cucumbers, and tomatoes. In addition, legumes, potatoes, nuts, oranges, whole grain cereals, wheat germ and soya contain large amounts of folic acid. Folate is also found in some foods of animal origin, such as milk and dairy products, eggs and liver (NZIP 2023; Roubík 2018).

Folic acid is found in leafy vegetables (lettuce, kale, spinach), broccoli, beans, beetroot, fruit and nuts, yeast and liver (Kladenský 2017).

Vitamin B12 (cobalamin)

This vitamin is essential for the normal production of red blood cells in the bone marrow and for nerve cells' growth (Akram et al. 2020). Vitamin B12 is the only one of the B vitamins that the body stores in reserve (especially in the liver), where it can last for several years if it is deficient (Kladenský 2017). This vitamin is not present in common plant food, and it is possible to find it in meat, milk, liver, fish, eggs, and cheese (Roubík 2018).

Vitamin C (ascorbic acid)

In the body, vitamin C acts as an antioxidant and helps protect cells from damage caused by free radicals. Free radicals are compounds that are formed when ingested food is converted into energy. The body also needs vitamin C to form collagen (a protein needed for wound healing). In addition, vitamin C improves the absorption of iron from plant foods and helps the proper function of the immune system, which protects the body from disease (NIH 2019). Severe vitamin C deficiency causes scurvy. The main symptoms of this disease include bleeding from the gums into the skin, into the muscles, joints, and internal organs, cramps, swelling, and psychologically manifested by depression (Kladenský 2017). The main source of vitamin C is fresh fruit and vegetables. High content of this vitamin is present in blackcurrants, red pepper, broccoli, kiwi, citrus, and other tropical fruits (Roubík 2018).

1.1.2.2. Minerals and trace elements

Minerals in nutrition are divided into two categories. Major minerals (sometimes called macrominerals) are needed in the diet and are found in the body in large amounts. Trace minerals are needed in smaller amounts in the diet and are found in smaller amounts in the body. All major and trace minerals are essential for nutrition (Johnson 2023).

Minerals are essential inorganic compounds that have no energy value. However, they contribute many indispensable functions in our body – they maintain homeostasis (the stability of our body's internal environment), allow muscle contraction and movement, help supply all our cells with oxygen, and are part of thousands of different enzymes in the body (Roubík 2018).

Macrominerals are nutritionally important minerals and are classified as macronutrients because the average daily requirement of an adult should be greater than 100 mg/day. As the name suggests, trace elements are a basic group of minerals that are required in small amounts for everyday metabolic processes in humans. Therefore, they are considered trace elements because their daily requirement should be less than 100 mg, above this value can be toxic to health. However, deficiency of any of these trace elements can be serious and can lead to serious health problems (Roubík 2018; Akram et al. 2020).

Macro minerals include sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), and sulphur (S). These substances play a vital role in regulating osmotic pressure, thereby maintaining fluid balance in the body. Adequate intake of minerals can support the overall health of the body. Trace elements include mainly iron (Fe), zinc (Zn), iodine (I), cobalt (Co), fluorine (F), chromium (Cr), selenium (Se), copper (Cu), manganese (Mn), silicon (Si) and others (Blake 2007; Roubík 2018; Akram et al. 2020).

Macrominerals

Sodium (Na)

Salt (sodium chloride, NaCl) is not only used to flavour food but is also a source of sodium (Na+) and chloride ions (Cl-), which are essential for our bodies to function. Nowadays, there is a problem with the consumption of higher amounts of salt than is recommended. Excessive salt consumption promotes increased blood pressure, heart failure, stroke and health problems associated with water retention in the body. Too much salt binds water in the body, causes swelling, increases blood volume, puts more strain on the heart, and increases blood pressure in the blood vessels, which has an adverse effect on our health (Hrnčířová et al. 2012).

Potassium (K)

Potassium is a mineral that is essential for all of the body's functions. It helps nerves, muscles, and heart function well and also helps move nutrients and waste around your body's cells (Navi 2013).

Consumption of potassium is connected with a reduction in the risk of some diseases. We classify here decreased risk of brain infarction (stroke), reduction of the acid content of the diet and preservation of calcium in bones (preventing osteoporosis), and decrease urinary calcium excretion, thereby potentially prevents kidney stone formation (Engel 2010).

Potassium is found in many foods, for example, in fruits (dried apricots, prunes, raisins, banana), vegetables (potatoes, spinach, tomatoes), lentils and beans, milk and yoghurt, and meat and fish (NIH 2021a).

Calcium (Ca)

Calcium is essential for maintaining strong and healthy bones and teeth, supporting proper blood clotting, facilitating muscle function, and playing a crucial role in nerve transmission. Adequate calcium intake is particularly vital during periods of growth, such as childhood and adolescence, and it can contribute to preventing osteoporosis and promoting overall bone health throughout one's life (NIH 2024).

Calcium is present in many foods, such as vegetables (spinach, kale), milk and milk products, fish and seafood, tofu, and other meat alternatives (Dietitians of Canada 2015).

Magnesium (Mg)

Magnesium is a nutrient that the body needs to maintain health. Magnesium is important for many processes in the body, including the regulation of muscle and nerve function, blood sugar and blood pressure, and the formation of protein, bone and DNA (NIH 2021b). In women, in particular, there are various physio-pathological conditions that can increase the need for magnesium, which is useful for the prevention and treatment of disease. Magnesium is well-known in the field of obstetrics and gynaecology. The use of magnesium in women is widespread in many health problems, such as premenstrual syndrome, also during pregnancy, post-menopause and others (Porri et al. 2021). Magnesium is a nutrient the body needs to maintain health. Foods such as beans and

legumes, dairy products, dark green leafy vegetables, nuts and seeds or fruits and vegetables are high in magnesium (Advent Health 2023).

Phosphorus (P)

Phosphorus is a component of bones, teeth, DNA and RNA. In the form of phospholipids, phosphorus is also part of the structure of cell membranes and a key source of energy in the body. In addition, phosphorus plays a key role in the regulation of gene transcription, enzyme activation, maintenance of normal pH in extracellular fluid, and energy storage in cells. In humans, phosphorus makes up about 1 to 1.4 percent of fat-free mass. Of this amount, 85 percent is found in the bones and teeth, and the remaining 15 percent is dispersed in the blood and soft tissues (NIH 2023a). Phosphorus is found in almost all foods, where it is found in the form of phosphates. Protein-rich foods are usually also high in phosphate. Good sources of phosphorus are liver, meat, sausages, milk and dairy products, bread and eggs (Tůmová 2014).

Sulphur (S)

Sulphur is the third most abundant mineral in the body. It is contained in methionine and cysteine, two amino acids that make up proteins. Both of these amino acids are present in the skin, hair, and nails, and they help to firm and make these tissues more elastic. You get the sulphur your body needs from animal and plant proteins, as well as other types of compounds such as sulfinates, allicin and sulfides. Sulphur is also found in thiamine (vitamin B-1) and biotin (vitamin H). Garlic, radishes, horseradish and eggs are well-known sources of this macromineral (Mikstas 2022).

Trace elements

Iron (Fe)

Iron is a mineral that the body needs for its growth and development. The body uses iron to make haemoglobin, a protein in red blood cells that carries oxygen from the lungs to all parts of the body, and myoglobin, a protein that supplies oxygen to muscles. The body also needs iron to make certain hormones. The amount of iron needed depends on an individual's age, gender and whether you eat a predominantly plant-based diet, as vegetarians who do not eat meat, poultry, or seafood need almost twice as much iron. Iron is found in a variety of foods, especially red meat, poultry, fish and plant sources such as legumes, fortified cereals and dark green leafy vegetables (NIH 2023b).

Zinc (Zn)

Zinc is an essential micronutrient for humans, playing an important role in protein, lipid and nucleic acid metabolism and gene transcription. Its role in the human body is extensive in the areas of reproduction, immune function and wound repair. At the microcellular level, it has a significant effect on the normal functioning of macrophages, neutrophils, natural killer cells and complement activity. Although zinc is one of the most abundant trace elements in the human body, it cannot be stored in significant amounts, and therefore, it requires regular intake or supplementation. Zinc is found in a variety of foods, including meat, fish, legumes, nuts and other food sources, although its absorption varies depending on the substrate that carries it (Maxfield et al. 2023).

Iodine (I)

Iodine is an essential micronutrient needed for the synthesis of thyroid hormones, which supports growth and development. Persistently low iodine intake leads to iodine deficiency or even damage to the developing brain and other harmful effects, collectively referred to as iodine deficiency disorders (IDD) (Centre for Food Safety 2023). The richest sources of iodine in foods are fish, milk and dairy products (Bath & Pettitt 2022).

Cobalt (Co)

Cobalt is essential for humans in the form of vitamin B12, which contributes to healthy blood cell formation and neurological health. The main sources of cobalt are beans, liver, meat, fish, eggs and butter. Smaller amounts are found in nuts, whole grains, vegetables and fruits (Cobalt institute 2023).

Fluorine (F)

Fluorine is a chemically reactive electronegative single-component gaseous halogen that occurs naturally in water, soil, animals and plants. Due to its property of being highly reactive in nature, overexposure to fluorine can cause a number of adverse health effects, including dental caries, osteoporosis, kidney, bone, reproductive organ, muscle and nerve damage. In the human body, fluorine is found in trace amounts in all mineral tissues of the body in the form of enamel, dentin and bone, as well as in many enzymatic reactions. However, certain fluorine-containing compounds, such as fluoride in dental products, can offer dental health benefits, as mentioned in the previous response (Das & Pooja 2021).

Chromium (Cr)

Chromium is an essential trace mineral. There are two forms: trivalent chromium, which is safe for humans, and hexavalent chromium, which is a toxin. Trivalent chromium is found in foods and dietary supplements. It can help maintain normal blood sugar levels by improving the way the body uses insulin. People take chromium when they are deficient. It is also used for diabetes, high cholesterol, sports performance, bipolar disorder, and many other purposes, but there is no good scientific evidence for most of these uses (NIH 2022a).

Selenium (Se)

Selenium is an essential mineral, which means it performs many functions in the body, such as strengthening the immune system, protecting against infertility and cognitive decline, and improving thyroid function (Dorwart 2023). Selenium is a cofactor for enzymes that release active thyroid hormone in cells, so low levels can cause symptoms similar to iodine deficiency. Another function of selenium is as an antioxidant (USDA 2010). Foods are naturally high in selenium, especially Brazil nuts, meat, and seafood (Dorwart 2023).

Copper (Cu)

Copper is a key trace element involved in blood formation, bone structure and the proper functioning of the nervous system. It is important for the formation and growth of new cells. Sources are mainly tripe, nuts, cocoa and mushrooms (NIH 2022b).

Manganese (Mn)

Manganese is essential for the proper functioning of the human body, the proper function of the nervous system, and reproduction, and it is a component of many enzymes. Low levels of manganese in the body can contribute to infertility, bone malformation, weakness and seizures. However, too much manganese in the diet can lead to high levels of manganese in body tissues. On the other hand, abnormal concentrations of manganese in the brain have been linked to neurological disorders similar to Parkinson's disease. Exposure to high or low levels of manganese at an early age can affect the development of the nervous system. Elevated manganese levels are also associated with poor cognitive performance in school children. It is found in tea, oatmeal and nuts (Health Library 2022).

Silicon (Si)

Silicon is integral to the synthesis of various enzymes, promoting optimal metabolic function and cellular activities. Silicon, a trace mineral abundant in nature, is proving to be an essential ingredient for stronger bones, better skin and more flexible joints. Including silicon in the diet can enhance the effects of calcium, glucosamine and vitamin D. In addition to connective tissue and bone health, several other promising health benefits of silicon have been noted, such as protection from aluminium toxicity and protection of arterial tissue. Fibre-rich foods such as cereals, oats, wheat bran, and vegetables contain high concentrations of silicon. An unbalanced diet with a limited intake of vegetables, fruits and grains will have a low concentration of silicon (Gonzales 2023).

1.1.3. Recommended nutrient intake for women

Dietary recommendations are a guide, not a goal because each person is an individual and personal needs vary depending on gender, size, age and activity level. Table 1 and Table 2 provide the reference intake (RI) or daily micro and macro nutrients intake recommended for the average, moderately active woman to achieve a healthy, balanced diet for weight maintenance, not for weight loss or gain (this recommendation changes during pregnancy and lactation when nutrient requirements are higher) (Foundation 2018; Torrens 2023). Eating a variety of food groups, including different food components, is essential for achieving optimal daily dietary intake and obtaining all recommended nutrients (Federal Government of Ethiopia 2022).

Table 1 Recommended nutrient intake for women (Foundation 2018; Torrens 2023)

Energy	2,000 kcal
Fat	Max. 78g (or 35 percent of food energy)
Saturated fat	Max. 24g (or 11 percent of food energy)
Carbohydrates	Min. 267g (or 50 percent of food energy)
Free sugars	Max. 27g (or 5 percent of food energy)
Protein	45-50g
Fibre	30g
Salt	Max. 6g

Table 2 Recommended micronutrients intake (Foundation 2018; Torrens 2023)

Vitamin A	600µg/d
Thiamin	0.8mg/d
Riboflavin	1.1mg/d
Niacin	13.2mg/d
Vitamin B6	1.2mg/d
Folate	1.2mg/d
Vitamin B12	1.5µg/d
Vitamin C	40mg/d
Vitamin D	10µg/d
Calcium	700mg/d
Phosphorus	550mg/d
Magnesium	270mg/d
Potassium	3500mg/d
Iron	14.8mg/d
Zinc	7.0mg/d
Copper	1.2mg/d
Selenium	60µg/d
Iodine	140µg/d

d = day

1.2. Important dietary components and their benefits

All relevant micro and macronutrients are found in the individual components of the diet. The particular benefits of each dietary component may be the physiological component contained in the food, the function that the food performs or the nutrients contained. West (2006) states that the most important dietary components are cereals, pulses, milk and dairy products, meat, fruits and vegetables. Eggs, fish and cheese are also integral parts of a good diet.

1.2.1. Meat

Meat, as one of the most essential food group, is the most valuable source of proteins, and also contains fats, B vitamin complex, vitamins A and D, large amounts of iron, zinc, and other mineral substances. Although meat consumption is nowadays associated with a number of diseases, such a cardiovascular disease, cancer and diabetes, meat has a significant role not only for maintenance of proper growth, development and health (Baltic & Boskovic 2015).

The nutrient content of meat varies according to the type of animal and the part of the body from which the meat comes. Fatty meat has a lower water content, and meat with a lower fat content has more water. Meat also contains many minerals such as phosphorus, potassium, calcium, magnesium, iron and B vitamins. We should include less fatty meat in our diet, especially chicken, turkey, veal, lamb and rabbit. Poultry meat is currently emphasised but is poorer in vitamins and minerals, so it is recommended to occasionally supplement the diet with lean veal or lamb and beef, which are rich in iron, zinc and B vitamins (niacin, B12). Lean pork is slightly fattier than lean beef and should be eaten less frequently, as animal fat does not contribute to the heart and blood vessels. Tripe is a rich source of vitamin A, folic acid and iron (Hrnčířová et al. 2012).

1.2.2. Fish

Fish, as a food group, is a unique source of nutrients with metabolic and hormonal importance, including omega-3 fatty acids, iodine, selenium, vitamin D, taurine and carnitine. Fish are also a source of high-quality protein and are generally low in calories.

Fish proteins such as immunoglobins act as defences against viral and bacterial infections and prevent protein-calorie malnutrition (Mendivil 2021).

Different types of fish (marine, freshwater) should be regularly rotated in the diet and eaten up to 2-3 times a week (Hrnčířová et al. 2012).

1.2.3. Milk and dairy products

Milk and dairy products contain all three essential nutrients (proteins, fats and carbohydrates) and a large number of vitamins and minerals. Dairy products provide 50-70 percent of our body's calcium and play a protective role in relation to osteoporosis from childhood onwards (Hrnčířová et al. 2012; Warsewicz et al. 2019).

The milk protein casein, which is most abundant in milk, has a protective function for the liver and has a significant effect on growth activity. Casein is the main protein in cottage cheese. In addition to proteins, zinc and lysozyme are the main contributors to increasing the body's immunity (Hrnčířová et al. 2012).

1.2.4. Cheese

Cheeses contain significant amounts of crucial nutrients, especially proteins and bioactive peptides, amino acids, fats, fatty acids, vitamins and minerals. All the nutrients in cheese are present in much higher concentrations than in the milk from which it is made. For example, the protein content of cheese is between 6-30 percent, which is 2-10 times higher than in milk. Cheese also has positive effects on human health. For example, calcium, which is present in large quantities in cheese, has a positive effect on various disorders (hypertension, osteoporosis, obesity and tooth decay) or bioactive peptides, which reduce hypertension (Walther et al. 2008; Hrnčířová et al. 2012).

1.2.5. Eggs

Eggs are a controversial food from a health perspective due to their relatively high cholesterol content. However, many studies on healthy and unhealthy people show that egg consumption is not associated with an increased risk of heart disease. On the contrary, eggs contain several nutritional components that protect against chronic diseases, including lutein, vitamin D, selenium and vitamin A. Eggs are also an important source

of high-quality protein with all essential amino acids and are recognized for their high biological value (Puglisi & Fernandez 2022).

1.2.6. Cereals

Cereals and their products are a staple in the diets of most people in the world. These foods are a very good source of energy, which our bodies can use well and sometimes very quickly. They are also a source of vitamins, minerals and fibre (Laskowski et al. 2019).

Foods from this group help to lower cholesterol levels, treat complex metabolic syndrome or obesity, type II diabetes and gastrointestinal diseases due to their high vitamin and fibre content. Cereals are a rich source of B vitamins, which also have a good effect on the balanced functioning of the nervous system (Pal & Molnár 2021).

Cereals are characterised as edible seeds or grains of grasses and the most commonly grown are wheat, rye, oats, barley, maize, triticale, millet and sorghum. The flour, bread, and other baked products produced by cereals also play an important role in disease prevention and international gastronomy (McKevith 2004; Pal & Molnár 2021).

1.2.7. Pulses

Pulses are one of the food groups which provide the highest concentration of zinc and iron and have high micronutrient density (FAO/WHO Expert Consultation 2005). Pulses also contain a relatively large amount of protein, which, when combined with cereals, forms a quality protein comparable to animal protein. The fat content is low (with the exception of soya and peanuts, whose fats are, however, beneficial to health) and is not accompanied by cholesterol as in animal foods. This food group is a rich source of dietary fibre and contains relatively high levels of minerals and some vitamins (B vitamins) (Hrnčířová et al. 2012).

The most common examples of this food group are common bean, broad bean, chickpea, pigeon pea, cowpea, lentil, and soybean (FANTA 2016).

1.2.8. Fruits and vegetables

Fruits and vegetables are an essential part of the human diet because they contain large amounts of fibre, vitamins, minerals and antioxidants. Low consumption of fruits and vegetables is associated with chronic diseases such as cardiovascular disease, suboptimal blood pressure, osteoporosis, many cancers, respiratory problems and mental disorders (Pem & Jeewon 2015).

Increased consumption of fruit and vegetables also helps reduce consumption of foods high in saturated fat, sugar or salt. Some fruits contain large amounts of vitamins. Blackcurrants, gooseberries, strawberries, redcurrants, blackberries and lemons contain the most vitamin C. In terms of minerals, fruits contain large amounts of potassium, magnesium, iron (peaches, raspberries, oranges), manganese (red and white currants, blueberries, pineapple), copper (figs, dates, bananas), zinc (raspberries, gooseberries, strawberries, grapes, blackberries, black and red currants) and iodine (cherries, blackberries, raspberries, blueberries and red currants) (Golovinskaia & Wang 2021).

Vegetables are a crucial source of provitamin A, which is found in carrots, tomatoes and spinach. Vitamin B1 is most abundant in peas, asparagus, parsley, broccoli, tomatoes and spinach. Vitamin B2 is found in spinach, green beans, peas, cauliflower and lettuce. Lettuce, peas, beans, kale, tomatoes, zucchini and green salad are sources of vitamin B6. Vegetables are also important sources of vitamin C, K and folic acid. Peppers, kale, kohlrabi, horseradish, patisons and green sprouts contain the most vitamin C. Vitamin K is abundant in leafy vegetables and folic acid is found in dark leafy vegetables such as spinach, as well as cauliflower, parsley and pumpkin. Among minerals, vegetables contain calcium, which is abundant in parsley, carrots, cabbage and kale (Hrnčířová et al. 2012).

1.3. The food security situation in Ethiopia

Ethiopia is a country located in the Horn of Africa, with a population of around 123 million, which ranks Ethiopia as Africa's second most populous nation, following Nigeria (Embassy of Ethiopia 2022; The World Bank 2023). It is marked as one of the fastest-growing economies in the region, registering an estimated growth of 6.4 percent in 2021/22, despite grappling with a per capita gross national income of 1,020 USD and

a goal to achieve lower-middle-income status by 2025. Ethiopia's growth, sustained over the past 15 years, has averaged nearly 10 percent annually, driven primarily by capital accumulation, notably through substantial investments in public infrastructure. Although economic growth slowed in recent years due to shocks (including the impact of COVID-19), the agricultural sector, employing over 70 percent of the population, remained resilient. However, conflicts in various regions pose a threat to the country's development progress. Despite positive trends in poverty reduction and improved human development indicators, Ethiopia's achievements are comparatively modest, and rising inequality is a growing concern (UNDP 2022; The World Bank 2023).

Nowadays, communities in Ethiopia, together with Kenya, Somalia and Nigeria, face the worst food crisis in decades, concretely in 40 years. The main causes of this crisis are ongoing climate change in Africa, war conflict in Ukraine, inflation worldwide, and the devastating rise in world food prices (British Red Cross 2023). These issues have far-reaching impacts on food security, nutrition, water accessibility, healthcare, livestock maintenance, education, and protective services (OCHA 2024). At the same time, 9.4 million people across Tigray, Afar and Amhara regions are in need of food assistance due to the impacts of conflict, and 11.8 million people across the country are facing severe hunger due to drought (WFP 2024). In 2023, more than 20 million people were facing food insecurity in Ethiopia (The World Bank 2023). Further, one million people also needed food aid, and 7.4 million women and children suffered from malnutrition (WFP 2024). The severe drought attributed to the El-Niño phenomenon has plunged millions of people into destitution. Crop failure between June and August 2023 caused food shortages and malnutrition. Affected populations were depleting household food supplies, deteriorating livestock health, exhausting coping mechanisms and resorting to begging and migration. Water shortages, especially in remote areas inhabited by pastoralist and nomadic communities, are driving families to even greater desperation (OCHA 2024). Figure 1 illustrates a concerning food security scenario in Ethiopia in October 2023, with over half of the country falled into Integrated Food Security Phase Classification (IPC) 2 or higher. This signifies that a large portion of the population was facing high levels of acute food insecurity, requiring interventions to prevent further deterioration. Additionally, mainly areas with increased conflicts were marked as IPC 3 (Crisis) and IPC 4 (Emergency), indicating severe food shortages, elevated malnutrition rates, and potential excess mortality. The widespread distribution of IPC 2 and above underscores

the urgent need for comprehensive and targeted interventions to address the escalating food crisis affecting various parts of Ethiopia (FEWS NET 2024).

The *deyr/hageya* rains, typically spanning from October to December in the south and southeast, concluded with some of the highest cumulative totals recorded in the 40-year historical data, attributed to the persistent influence of El Niño. Notably, parts of the Somali Region experienced rainfall exceeding 300 percent of the normal average. This unprecedented rainfall resulted in extensive flooding across the Somali, Oromia, and South Ethiopia regions in October and November. The floods led to significant population displacement, compelled pastoralists to relocate their livestock to higher ground, and caused the loss of main-season crops, particularly affecting agropastoralists in riverine areas along the Shebelle and Omo rivers. As of mid-December, reports from the Office for the Coordination of Humanitarian Affairs (OCHA) indicated that over 616,000 people had been displaced or lost their homes in the Somali, South Ethiopia, and South West Ethiopia regions. The annual multi-partner seasonal assessment conducted in December highlighted the grim impact, with nearly 27,000 livestock fatalities and the destruction of over 72,000 hectares of planted crops. The destruction of critical infrastructure, including roads, led to short-term disruptions in market activities and trade flows (DATA 2023; Amente & Dione 2024; FEWS NET 2024).

Poor conditions have also affected prices in local markets in Ethiopia. Staple food prices in local markets experienced a seasonal decline from October to November 2023, driven by increased supplies from the *meher* harvest. In Tigray Region, maize and sorghum prices dropped by 28 percent and 10 percent month-on-month, respectively. Despite this, white sorghum prices in November remained 8 percent higher than last year and 52 percent higher than the three-year average. Conversely, in Afar, maize prices notably rose due to local grain supply shortages, high transportation costs, and inflated production costs. For instance, in the Chereti market, the price of maize was nearly 90 percent higher than last year and over 160 percent higher than the three-year average. In terms of livestock, market supply and prices increased across much of the country, driven by favourable body conditions and inflationary market pressure, particularly in the pastoral areas of Afar and Somali regions (HRW 2021; FEWS NET 2024).

Last but not least, armed clashes in northern Amhara and central Oromia led to ongoing displacement, regular disruptions to market operations and a significant impact

on local livelihoods (FEWS NET 2024; WFP 2024). As a result of conflicts and floods, displacement rates were very high. Although data collection has been difficult due to the conditions, an estimated 4.3 million people were identified as displaced in June 2023, with the displacement rate decreasing to 3.5 million in September of the same year (FEWS NET 2021).

In summary, Ethiopia is facing a serious crisis characterised by severe food shortages, widespread displacement, ongoing conflict and economic problems. In 2023, more than 20 million people faced food insecurity, with conflict and drought particularly affecting the Tigray, Afar and Amhara regions. Drought and flooding have led to crop failure, food shortages and displacement. Armed clashes persist in northern Amhara and central Oromia, exacerbating the problems. To improve the situation, local and international efforts are needed to address humanitarian needs, restore stability and facilitate sustainable development.

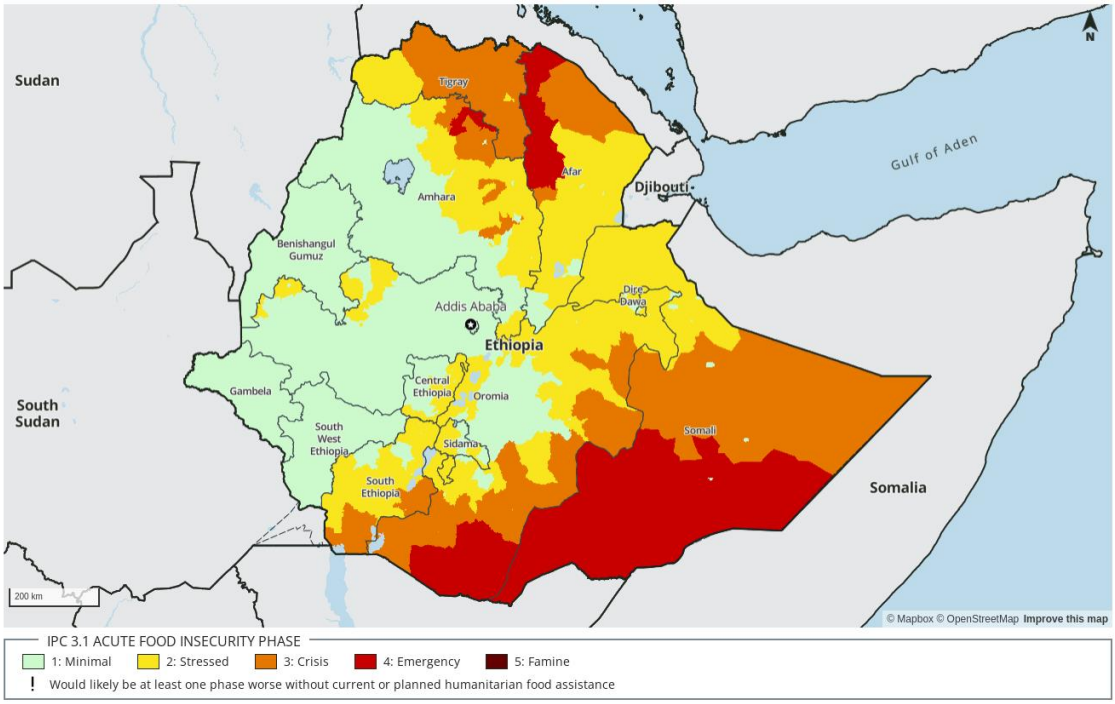

Figure 1 Food security outcomes, Ethiopia, October 2023 (FEWS NET 2024)

1.3.1. Nutrition–related diseases in Ethiopia

By 2023, the number of food-insecure people in Ethiopia exceeded 20 million, and the level of food insecurity was defined as serious (Global Hunger Index 2023). Food insecurity can be defined as a lack of consistent access to different food components for

an active and healthy life. It is important to know that although hunger and food insecurity are closely related, they are different concepts. Hunger refers to a personal, physical feeling of discomfort, while food insecurity refers to the lack of available financial resources for food at the household level (US Department of Agriculture 2019). For those facing food insecurity, access to food is precarious. These individuals may be forced to sacrifice other basic needs just to be able to eat. There is also the problem that people in food poverty often consume the most readily available or cheapest foods, which are often poorly nutritious. Highly processed foods high in energy, saturated fats, sugars, and salt are often cheaper and more readily available than fresh fruit and vegetables. Daily calorie needs can be reached by eating these foods, but essential nutrients that keep the body healthy and functioning well are absent (FAO 2022).

According to Laraia (2013) and Seligman et al. (2010), food insecurity is highly associated with nutrition-related diseases. These diseases cover a wide range of conditions, including general malnutrition, overnutrition leading to obesity, eating disorders and diseases in which nutrition plays a key role. Within Ethiopia, prevalent nutrition-related diseases include mainly protein-energy malnutrition (PEM), deficiencies in essential nutrients such as vitamin A, zinc, calcium, or folate, cardiovascular diseases (CVD), and type 2 diabetes mellitus (T2DM) (Bekele et al. 2023a).

1.3.1.1. Protein energy malnutrition (PEM)

The World Health Organization (WHO) has defined malnutrition as the physical manifestation of hunger caused by a deficiency of one or more essential nutrients. It affects various human processes such as growth, pregnancy and lactation, cognition, resistance to disease, and healing. It also reduces people's ability to work and limits their physical performance (WHO 2018).

PEM is a common disease found not only in countries of the Global South but also in industrialized countries. It refers to a poor nutritional status caused by a lack of protein and energy that leads to the depletion of the body (Grover & Ee 2009). PEM manifests as underweight (low body weight compared to healthy peers), stunting (poor linear growth), and wasting (acute weight loss) (Ahmed et al. 2020). According to Kanan and Swar (2016), PEM is divided into marasmus and kwashiorkor, or a mixture of both marasmic and kwashiorkor.

Marasmus

Marasmus is the most prevalent severe form of malnutrition and the most crucial nutritional disease in developing countries. A lack of energy-dense foods prevails over a lack of protein. Its origin may be primary, caused by inadequate food intake, often associated with infectious or parasitic diseases, or secondary, caused by other conditions that interfere with nutrient absorption or assimilation (Franch & Valls 2003).

Marantic-type malnutrition is caused by insufficient intake of all nutrients (energy and protein), so-called balanced starvation. The body's adaptive mechanisms are preserved, and metabolism slows down. The clinical diagnosis is obvious at first sight - we find extremely reduced body fat and muscle atrophy with extremely low weight (usually below 60 percent of normal). Vitamin and electrolyte metabolism is disturbed. If a person does not take in food for more than 24 hours, we speak of starvation (within 24 hours, the term starvation is used). In starvation, the human body uses its own resources. If the diet does not provide the body with enough energy, first glycogen stores are depleted, later fat stores. Eventually, the proteins of the active body mass are also used as an energy source, leading to the breakdown of muscles and body organs. At the beginning of starvation, an intense feeling of hunger appears when eating, gradually the appetite decreases until it disappears completely. The main symptom in children is stunting - children are smaller than their growth potential (Hejmalová & Hrnčiříková 2012a).

Kwashiorkor

Kwashiorkor is a disease characterized by severe protein malnutrition and usually affects infants and children, most commonly between the ages of weaning and five years. The cause is a diet deficient in protein and with a relative or absolute excess of energy intake, mostly from carbohydrates. The disease is not always caused by the unavailability of food but often by various superstitions prohibiting the consumption of foods of animal origin, i.e. eggs, milk and meat (Hejmalová & Hrnčiříková 2012a).

This disease is characterized by symptoms such as an extremely thin figure with large swellings of the abdomen, lower limbs and ankles (Konupková 2017). The delay in growth is less than in marasmus, as is the reduction in body weight. This is due to the fact that, as a result of higher energy intake, children have a larger or smaller layer of subcutaneous fat. Hair tends to be sparse, thin, fine and often unpigmented, as is the skin.

Children have diarrhoea, are usually anaemic and often have severe psychomotor changes. They are apathetic, have no appetite, and their motor development is delayed. Mental retardation is severe and irreversible. Children often die from associated infections (Hejmalová & Hrnčiříková 2012a).

Marasmic-kwashiorkor

This type of malnutrition combines the clinical features of marasmus and kwashiorkor. Its main characteristics are the presence of oedema (with or without skin lesions), muscle wasting and reduced subcutaneous fat as in marasmus (Hejmalová & Hrnčiříková 2012b).

1.3.1.2. Deficiencies in essential nutrients

Vitamin A deficiency

Dietary intake of vitamin A that is insufficient to meet physiological needs is a consequence of vitamin A deficiency. It may be aggravated by a high incidence of infections, especially diarrhoea and measles. It is common in developing countries but rare in developed countries. Vitamin A deficiency (VAD) is a public health problem in more than half of the countries, particularly in Africa and Southeast Asia. The most serious consequences of deficiency are seen in young children and pregnant women in low-income countries (FAO 2009). One of the causes of VAD is night blindness (in which it is difficult or impossible to see in relatively low light), which is common during pregnancy (Tadesse et al. 2005). Vitamin A deficiency is also associated with higher childhood morbidity and mortality (Greiner 2013).

Zinc (Zn) deficiency

Approximately one-third of the world's population is zinc deficient. In children, it causes growth retardation and problems with learning, psychomotor and neuro-behavioural disorders. It also affects sperm production and maturation and fetal and immune system development (Oliver & Brevik 2023).

In general, Zn deficiency is manifested by stunted growth, poor wound healing, reduced sexual performance, abnormal hair and nails, loss of appetite, gastrointestinal disorders (anorexia, abdominal pain) and impaired absorption of folic acid and vitamin A. Zn is also important for neurobehavioural function, and its deficiency can lead to increased anxiety and depression (Swaminathan & Singh 2022).

Calcium deficiency

Calcium deficiency can reduce bone strength and lead to osteoporosis, characterised by brittle bones and an increased risk of falling. Calcium deficiency can also cause rickets in children and other bone disorders in adults, where children with rickets do not have normal mineralisation of the growth cartilage, which can lead to irreversible changes in the skeletal structure. Another consequence of chronic calcium deficiency is osteomalacia, or defective bone mineralisation and softening, which can occur in both adults and children. One of the most at-risk groups for calcium deficiency is postmenopausal women. Menopause leads to bone loss because the decline in estrogen production reduces calcium absorption and increases calcium loss through urine and the resorption of calcium from bone (NIH 2024).

Folate deficiency (vitamin B9)

Vitamin B9 deficiency is particularly evident in red blood cells, which are conspicuous under the microscope for their larger-than-average size (megaloblastic anaemia). Other manifestations may be disturbances in the growth and proliferation of other cells and tissues, such as white blood cells and cells in the intestine. During pregnancy, the need for vitamin B9 increases. Its deficiency in the first weeks of pregnancy can result in damage to the central nervous system (neural tube defect) in the baby, or it can cause premature birth. In adults, folic acid deficiency can lead to elevated homocysteine levels; elevated blood levels of this amino acid are associated with the occurrence of venous thrombosis and cardiovascular disease (NZIP 2024).

1.3.1.3. Cardiovascular diseases (CVD)

Cardiovascular disease (CVD) is the leading cause of death worldwide. An estimated 20.5 million people died from CVD in 2021, accounting for 32 percent of all deaths worldwide in 2019. Of these deaths, 85 percent were due to heart attack and stroke. More than three-quarters of CVD deaths occur in low- and middle-income countries. Of the 17 million premature deaths (aged under 70 years) due to non-communicable diseases in 2019, 38 percent were due to CVD. (WHO 2021; World Heart Federation 2023) Most cardiovascular diseases of the cardiovascular system, with the exception of birth defects, tend to occur in adulthood. After the age of 50, the number of cases of circulatory system diseases increases, and men are more often affected. Women are protected by female sex

hormones (estrogens) during their working years. At menopause, this protective effect disappears (MUNI 2012).

Most CVDs are preventable by addressing behavioural risk factors such as tobacco use, unhealthy and poor diet, obesity, physical inactivity and harmful alcohol use (WHO 2021; World Heart Federation 2023). Unhealthy and poor diet is a major risk factor, accounting for approximately 72 percent of CVD deaths, partly due to its influence on other major CVD risk factors. Although there have been modest improvements in diet quality over the past 20 years, addressing suboptimal nutrition is a priority for reducing the burden of CVD (Bowen et al. 2018).

(i) An unhealthy diet is closely linked to the causes of CVDs, which are for example (Boehringer Ingelheim 2023):

- Diabetes (high blood sugar level)
- High cholesterol (accumulation of fat in the blood vessels)
- Overweight and obesity
- Excessive intake of salt, fat or sugar

(ii) Among the CVDs we include (WHO 2021; Boehringer Ingelheim 2023):

- Heart failure
- Stroke - sudden interruption of blood circulation in the brain (blockage or restriction of blood flow through the brain or parts of it).
- Myocardial infarction - sudden disruption of the heart circulation (blockage or restriction of blood flow through the heart or parts of it)
- Ischaemic heart disease - narrowing or hardening of the arteries that oxygenate the heart
- Peripheral arterial disease - narrowing and hardening of the arteries that oxygenate the arms and legs
- Carotid artery disease - narrowing and hardening of the carotid arteries that oxygenate the brain
- Deep vein thrombosis and pulmonary embolism - blood clots in a deep vein in the leg that can break loose and move to the heart and lungs

1.3.1.4. Type 2 diabetes mellitus (T2DM)

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia (elevated sugar levels above the norm). It can be caused by impaired insulin secretion, resistance to insulin action, or both. In 2021, approximately 537 million adults between the ages of 20 and 79 had diabetes mellitus, and 6.7 million people died from this disease. By 2030, the disease is expected to increase to 634 million people (IDF

Diabetes Atlas 2022). Chronic hyperglycemia, along with other complications, can cause damage to various organ systems in patients with diabetes mellitus, leading to the development of disabling and life-threatening health complications that can lead to a 2- to 4-fold increase in the risk of cardiovascular disease. DM is divided into three types: type 1 diabetes, type 2 diabetes and gestational diabetes (Punthakee et al. 2018).

Type 2 diabetes mellitus (T2DM), one of the most common metabolic disorders, is caused by a combination of two main factors, which are impaired insulin secretion and the inability of insulin-sensitive tissues to respond adequately to insulin. These factors usually lead over time to damage to the heart, vasculature, eyes, kidneys and nerves. Nowadays, the main causes of the T2DM epidemic are the global increase in obesity, sedentary lifestyles, high-calorie diets and an ageing population (Galicia-Garcia et al. 2020).

1.3.2. Food security measurements

The quality and sufficiency of dietary intake can be measured by different dietary assessment methods. These methods are essential tools used to assess the intake of foods, nutrients or bioactive substances by individuals, groups or populations. The principle of dietary assessment involves first collecting information on foods and beverages consumed over a period of time, which is then coded and processed to calculate intakes of energy, nutrients and other dietary components using food composition tables (Dao et al. 2019). These methods can be broadly divided into two main types: objective and subjective (Bailey 2021).

Objective methods independently record dietary information and do not rely on input from individuals. They include direct observation, analysis of duplicate diets and the use of nutritional biomarkers. In contrast, subjective methods rely on information provided by the individual to obtain the most accurate data while minimising bias (Kirkpatrick & Raffoul 2017).

The choice of the appropriate evaluation method depends on a variety of factors, including the research question, study design, characteristics and sample size. Each method offers a unique perspective on an individual's diet and contributes to a comprehensive understanding of dietary patterns and their impact on health (Bailey 2021).

Traditional methods of dietary assessment include food records, food frequency questionnaires, 24-hour recall and screening tools; digital and mobile methods using technology are available for these traditional methods. This chapter describes primarily subjective tools (food record, dietary recall, food frequency questionnaires, screening tools, diet diaries and dietary diversity score), because they capture individual experiences, preferences, and variations, providing a more comprehensive understanding of people's actual eating habits and behaviours. Also, one objective method called Weighed food record is explained (Bailey 2021).

1.3.2.1. Food Record

Food records, also known as diet diaries, are a method of dietary assessment in which individuals keep detailed records of all the food and drink they have consumed over a period of time. Participants typically record the type of food, portion size, method of preparation and time of consumption. Food records provide a comprehensive and accurate description of food intake over a given time period, which can range from a few days to several weeks. However, they can introduce reactivity, where participants change their eating behaviour as a result of knowing that they are being observed (Kirkpatrick & Raffoul 2017; Bailey 2021).

1.3.2.2. The dietary recall (24HR)

The 24HR is a method used in nutrition research to collect detailed information about an individual's food and beverage intake over the past 24 hours. The purpose of the 24-Hour Dietary Recall is to gather information about the types and amounts of foods consumed, providing a snapshot of the individual's dietary habits. This method helps capture a more representative picture of an individual's usual food intake. According to Trumbo (2021), during the survey, respondents are asked to recall and describe everything they ate and drank during the previous day, including portion sizes, a list of ingredients, preparation methods, and any additional details.

This method relies on participants' memory, which may be prone to recall bias, leading to under- or overestimation of data (CLOSER 2024).

1.3.2.3. Food-Frequency Questionnaires (FFQs)

Food frequency questionnaires are structured surveys that measure the usual frequency of consumption of certain foods and food groups over an extended period, often over the last year. FFQs are cost-effective and suitable for large-scale studies. Participants provide information on their typical dietary habits and general consumption patterns, which can be established by this method. However, accuracy depends on the ability of participants to reliably recall their eating habits (Wageningen University and Research 2023).

1.3.2.4. Screening Tools

Screening tools play a crucial role in dietary assessment, offering shorter and more streamlined methods compared to comprehensive dietary assessment tools like FFQs. These tools are designed to quickly evaluate specific dietary components or patterns, making them particularly useful in large-scale studies and public health settings where time and resources are limited.

The advantage of using screening tools lies in their brevity and efficiency. Screening tools typically consist of a limited number of questions or prompts focused on the specific dietary component of interest. This makes them particularly suitable for large-scale epidemiological studies, where collecting detailed dietary data from a large sample size may be impractical. Furthermore, screening tools can serve as valuable tools for monitoring dietary trends and evaluating the effectiveness of public health interventions. By administering these tools at multiple time points, researchers and policymakers can track changes in dietary behaviours over time and assess the impact of interventions aimed at promoting healthier dietary patterns (Bailey 2021).

1.3.2.5. Diet Diaries

Diet diaries, also known as food records, involve participants keeping detailed records of everything they eat and drink over a period of time, similar to food records. This method offers a more accurate description of eating habits compared to recall. However, like food records, food diaries can introduce reactivity because individuals can modify their eating behaviour while recording their intake (CLOSER 2024).

1.3.2.6. Dietary Diversity Score (DDS)

DDS is defined as the number of different food items or food groups consumed over a given period of time (Ruel 2003). The process of measuring is based on counting the number of food groups rather than the individual food items consumed. The foods and drinks mentioned by the respondent are divided into different standardised food groups. The reference period is most often the previous day or week, but it may also vary according to the type of survey (Kennedy et al. 2010). Dietary diversity score can be measured on a household or individual level. On the household level, Household dietary diversity score (HDDS) and Food consumption score (FCS) are included. On individual level, Minimum Acceptable Diet (MAD), Minimum Dietary Diversity (MDD), Minimum Dietary Diversity for Women (MDD-W), and Women Dietary Diversity Score (WDDS/IDDS) are collected (INDDEX Project 2018).

WDDS is a measure used to assess the variety of food groups consumed by women over a specified period, providing insights into the nutritional diversity of their diets. A higher WDDS indicates a more diverse and potentially healthier diet. The women are asked to recall and name all the food they had consumed for the past 24 hours (day and night), that is, all dishes, snacks, and drinks. All the ingredients are afterwards coded into a list of 9 major food groups for analysis, according to the requirements for a women's diet diversity score proposed by FAO (Kennedy & Ballard 2010).

1.3.2.7. Weighed Food Record

Weighed food records require people to measure and record the weight of all food and drink they consume, both before and after eating. This method provides very accurate and objective data on dietary intake. However, it is labour-intensive for participants and researchers, making it less practical for long-term studies due to the burden it places on participants (Dao et al. 2019).

2. Aims of the Thesis

The main objective of the thesis was to examine the nutritional status of women in the Arba Minch Zuriya district, Gamo zone, SNNPR, Ethiopia and investigate dietary diversity and caloric intake along with factors affecting them.

3. Materials and methods

3.1. Study area description

This research was conducted in Arba Minch Zuriya district (woreda) in the Gamo Gofa zone in Southern Nation, Nationalities and People Regional State (SNNPRS) in the southern part of Ethiopia (as shown in Figure 2). The survey was done from July 2023 to December 2023, under the Czech Development Agency within the development project number ET-2020-066-DO-31130 titled "Arba Minch Fruit Value Chain, Gamo zone, SNNPR, Ethiopia". Arba Minch district is bordered on the north by Dita and Chencha, on the south by Dirashe special woreda, on the west by Bonke, and the east by the Oromia Region. The southeast is bordered by the Amaro special woreda, where two lakes, Abaya and Chamo, and their islands are located. Nechisar National Park is located between these lakes (Getaneh 2019). The total population was estimated to be 201,000 in 2022, in 2007 it was 75,000. Arba Minch Zuriya district is divided into 31 kebeles (smaller administrative units) (Bante et al. 2021). Gender division in this location is equal (50 percent of men and 50 percent of women) (Brinkhoff 2022). The temperature in this location is approximately 25.0 °C and the annual precipitation is approximately 2,818 mm (Climate Data 2023).

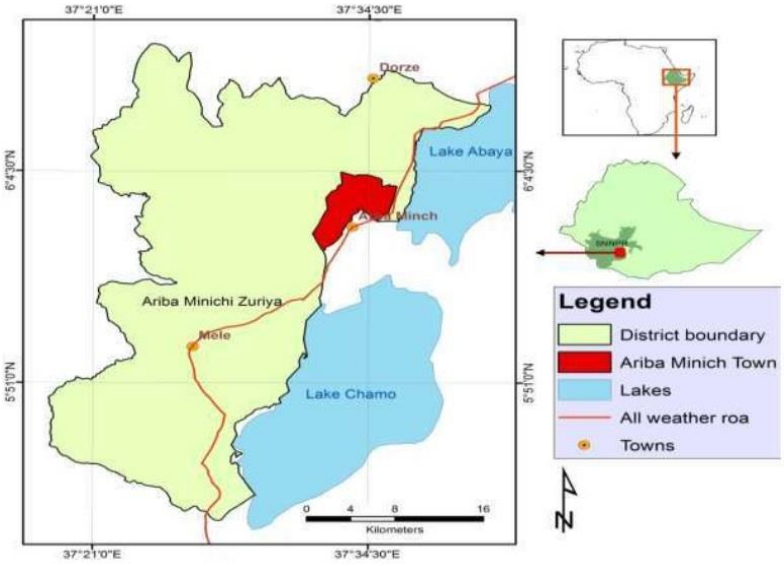

Figure 2 Map of Arba Minch Zuriya district (Molla & Fitsume 2017)

3.2. Research design

This study was conducted using a semi-structured quantitative questionnaire survey and qualitative research method of focus group discussion. Structured questionnaires and focus group discussions were used to collect primary data from the field.

3.2.1. Questionnaire survey

3.2.1.1. Sampling methods

A purposive sampling was used to select the respondents for the questionnaire survey, focusing on WRA participating project called "Arba Minch Fruit Value Chain, Gamo zone, SNNPR, Ethiopia". For the purposes of the survey, the upper age limit was raised (from 49 to 60 years) to collect more data and also because the lowest age found was 21 years. A total of 145 women were interviewed. The sample was collected in three different kebeles under Arba Minch Zuriya Local Government with almost equal numbers of female respondents. These kebeles were selected according to the cooperative groups that participated in the project. As seen in Figure 3, the selected kebele were called Chano Doriga kebele (n=41), Chano Mile kebele (n=53), and Chano Cheliba kebele (n=51). All interviews were conducted in the respondent's preferred language of Amharic, with the help of the extension officer (shown in Figure 4).

Figure 3 Four kebeles in the study area (Google 2024)

Figure 4 Questionnaire survey with the respondent in the presence of an extension officer (Author 2023)

3.2.1.2. Questionnaire design

A semi-structured questionnaire was considered the most suitable data collection instrument since it takes less time and helps collect information from respondents without the researcher's intervention. The questionnaire was composed of three main parts: (i) socioeconomic and demographic information about respondents, (ii) WDDS (iii) 24HR (see copy of complete questionnaire in Appendix 1).

Socioeconomic and demographic information about respondents

This part of the questionnaire held 21 questions, different measurements were used to measure the variables according to the nature and seriousness of the question being asked. The questionnaire contained these parts:

(i) Basic characteristics of respondents:

Name, age, level of education, religion, marital status, number of information panels.

(ii) Household characteristics:

Household size, household assets, sex of household head, sources of income, access to credit, places of food purchase, and expenditure on food.

(iii) Household agriculture and market practices:

Livestock and crops in household, livestock and crops in household as a source of income.

Women dietary diversity score (WDDS)

In this part of the questionnaire, the women recalled everything they had eaten and drank the previous day (previous 24 hours). All foods and drinks were recorded in a questionnaire. Afterwards, the information obtained was used to calculate the WDDS for each woman. Princip was defined as the sum of food groups consumed by a woman from the total of nine food groups required. The nine food groups included: (1) Starchy staples; (2) Dark green leafy vegetables; (3) Other vitamin A-rich fruits and vegetables; (4) Other fruits and vegetables; (5) Organ meat; (6) Meat and fish; (7) Eggs; (8) Legumes, nuts and seeds; (9) Milk and dairy products. According to Kennedy and Ballard (2010) the following equation was used for the calculation:

$$WDDS\ (0\text{-}9) = SUM\ (1+2+3+4+5+6+7+8+9) \quad (1)$$

where values for 1 through 9 will be either "0" or "1"

$$Average\ WDDS = SUM\ (WDDS) / Total\ Number\ of\ Women \quad (2)$$

Using WDDS allows women to be grouped into food-secure or insecure classes. A woman was classified as having poor dietary diversity and food insecurity if she had consumed <5 food groups or had achieved WDDS with good dietary diversity and was food secure if she had consumed ≥5 food groups during the previous 24 hours.

24-hour Dietary Recall (24HR)

In the 24HR section of the questionnaire, respondents were asked to recall and describe everything they ate and drank during the previous day, including portion sizes, list of ingredients, preparation methods, and any additional details. Different measurements were used to describe in detail a number of components (see all measurements in Appendix 1). The information obtained was then used to calculate the caloric intake of the individuals. In the 24HR analysis, each food with ingredients was calculated individually based on the caloric value of its components and then the totals for breakfast, lunch, and dinner were added (snacks were not present). The study by Bekele et al. (2023a) helped calculate the kcal value of meals. According to MRC Epidemiology Unit (2024), the equation described was used:

Disaggregate records

$$\textit{Individual Food or Ingredient} = \textit{Mixed Meal} \times (\textit{Proportion of Food} / \textit{Sum of Proportions in Mixed Meal}) \quad (3)$$

Convert portion size

$$\textit{Amount in Grams} = \textit{Portion Size} \times \textit{Conversion Factor}_{ij} \quad (4)$$

Match with food composition table

$$\textit{Nutrient Intake} = \textit{Amount in Grams} \times \textit{Nutrient Content per Gram} \quad (5)$$

Obtain daily nutrient intakes

$$\textit{Daily Nutrient Intake}_i = \sum_1^n \text{Nutrient Intake} \quad (6)$$

Moreover, the successful data collection in 24HR for data analysis involved only 47 respondents from the Chano Mile kebele.

3.2.2. Focus Group Discussions (FGD)

A voluntary sampling was used to select the respondents for FGD, focusing on women aged 15-60 years participating in a project called "Arba Minch Fruit Value Chain, Gamo zone, SNNPR, Ethiopia". In total, six women voluntarily participated in the discussion. For FGD the "Single focus group" type with only one discussing group was used. Discussions with the women were organized to obtain diverse experiences and opinions on their eating habits. The FGD was conducted by an extension officer who spoke both Amharic and English, where questions were asked in English and translated into Amharic. During the discussion, notes were taken. The results of FGD may be biased as it was translated from Amharic to English. The FGD took place in Arba Minch on 25th July 2023, from 9:00 am to 10:00 am. FGD was pre-tested with six women.

The main questions asked during the FGD were as follows:

1. What do you usually eat during the day (when it is not a fasting day)? Can you describe what you have for breakfast, lunch, snack and dinner?

1.1. What about snacks? Do you all eat snacks? What do you usually eat for a snack?

1.2. What about milk and dairy products? When do you eat them? How often is it?

2. What does your household plant? Home gardens/fields

2.1. Do you plant something in your house (garden)? How big is it? What do you plant?

2.2. What are the reasons for your choice? Why you don't plant teff instead of maize?

2.3. What do you do with your harvest? Do you consume your harvest or sell everything on the market?

3. If you have more money, which food you would buy more? Rank most important

3.1. Why did you choose these foods?

3.3. Statistical analysis

Firstly, data were entered and cleaned using Microsoft Excel, and all statistical analyses were performed using IBM SPSS Statistics version 29 (IBM, US). Descriptive statistics were used to present dietary diversity scores. For descriptive data, means and standard deviations (mean ± SD) were used.

Binary logistic regression was used to test the significance between the individual independent variables and the dependent variable (WDDS). The variables that showed significant association were considered for multivariate logistic regression, where significance was identified using the p-value of 0.05. The enter method during regression analysis was used. For example, Nkoko et al. (2023) used the same method in their study. In this study, sufficient consumption was ≥5 food groups (coded as "1"), and insufficient consumption was of less than five food groups (coded as "0"). The number of independent variables was 14, and all of them were categorical. The significance of the regression coefficients was tested using the Wald test. The quality of the logistic regression model was assessed using the Nagelkerke pseudo R-squared statistic, yielding a value of 0.513.

Equations for binary logistic regression and the Wald test are described as follows:

(i) Binary logistic regression

$$Logit(p) = \beta_0 + \beta_1 X1 + \beta_2 X2 + \beta_3 X3 ..... \beta_{14} X14 + u \quad (7)$$

X1: Age

X2: Education

X3: Religion

X4: Marital status

X5: Household head gender

X6: Household size

X7: N. of livestock in household

X8: N. of crop species in homegarden

X9: Household assets

X10: Source of food

X11: Sources of HH income

X12: Monthly expenditure on food

X13: Access to credit

X14: Source of information panels

u: Error term

(ii) Wald test

The Wald statistic for a predictor variable (X_i) is calculated as the square of the estimated coefficient divided by the square of its standard error:

$$Wald\ Statistic_i = (Coefficient\ Estimate_i / Standard\ Error_i)^2 \quad (8)$$

3.3.1. Model specification

As shown in the Table 3, some of the variables were determined based of other researches, while some variables were exploratory and chosen based on the knowledge of the researcher about the situation and respondents.

Table 3 Description of binary logistic regression variables

Variable name	Description	Categories	Source
Dependent variable			
WDDS	A number of food groups consumed by respondent during 24 hours. If food group is consumed than "1" is noted, if not "0".	<5 >5	(Kennedy G., Ballard T. 2010)
Independent variables			
Source of information	A summary of the information media used to acquire knowledge about nutritional requirements.	1-2 3-4	(FANTA 2016)
Sources of income	Sum of sources of income.	0-2 3-4	Explorative
N. of crops in homegarden	The number of species in homegarden.	0-5 6-10 11-15 15+	(Tesfaye Abebe 2005)
N. of livestock in household	Sum of all livestock in household.	0-5 6-10 11-15 15+	(Mosites 2016)
Food expenditure per month	Approximate food expediture per moth. Measured as lower, higher or middle of Ethiopian average.	<4500 ETB 4500 ETB+	(USDA 2021)
Level of education	Total number of years the respondent has spent in school. <8 years was considered primary education, >8 years was considered secondary education.	Without education Primary education Secondary education	(DHS 2011)
Household size	The number of members per household, measured as below or above the ethiopian standard.	0-5 5+	(Halala Handiso et al. 2020)
Age	The age of the responded, measured as a categorical variable.	20-29 30-39 40-49 50+	(Melaku et al. 2018)
Source of food	One or more places where women obtain food.	Market Market+own production	Explorative
Household assets	Summing the assets owned by individuals within the household.	0-1 2-3	(Office for National Statistics 2018)
Sex of household head	The sex of household head, male or female headed household.	Male Female	(FANTA 2016)
Marital status	Marital status of women, open-ended qusetion.	Married Divorced Widowed	(Nkoko et al. 2023a)
Access to credit	Having a credit or not.	Yes No	Explorative
Religion	The religion of respondents, open-ended question.	Orthodox Protestants	(Melesse & van den Berg 2021)

4. Results and discussion

4.1. Questionnaire survey

4.1.1. Socioeconomic and demographic information about respondents

In Table 4, the socioeconomic and demographic results of the questionnaire survey are shown.

Table 4 Characteristics of respondents (n=145)

Variable	Description	Number	Percentage	Mean	SD	Min.	Max.
Basic characteristics of respondents							
Age				42	8.8	21	60
	20-29	11	7.8				
	30-39	44	31.2				
	40-49	55	39				
	50+	31	22				
Years of schooling				4.7	3.9	0	13
	None	46	32.6				
	Primary	69	48.9				
	Secondary	26	18.4				
Religion							
	Protestant	115	81.6				
	Orthodox	26	18.4				
Marital status							
	Divorced	6	4.3				
	Married	125	88.7				
	Widowed	10	7.1				
Source of inf. (n. of inf. channels)				1.7	0.7	0	4
	1-2	126	89.4				
	3-4	15	10.6				

Table 5 Characteristics of respondents (n=145) (continued)

Household (HH) characteristics							
HH size				5.4	1.6	2	9
	0-5	69	48.9				
	5+	72	51.1				
HH head							
	Male	118	83.7				
	Female	23	16.3				
Sources				1.5	0.8	0	4
of income	0-2	124	87.9				
	3-4	17	12.1				
Expenditure on				4768	2109	600	11000
food (per month)	<4500 ETB	85	60.3				
	4500+ ETB	56	39.7				
Household assets				0.9	0.8	0	3
(n. of items)	0-1	110	78				
	2-3	31	22				
Source of food							
	Market	58	41.1				
	Market+own production	83	58.9				
Access to credit							
	No	104	73.8				
	Yes	37	26.2				
Household agriculture and market practices							
Livestock in HH				6.5	6.1	0	39
(n. of animals)	0-5	77	54.6				
	6-10	22	15.6				
	11-15	36	25.5				
	15+	6	4.3				
Crops in HH (n.				2.8	1.6	0	16
of crop species)	0-5	63	44.7				
	6-10	73	51.8				
	11-15	5	3.5				

ETB = Ethiopian birr, 1 ETB ≙ 0.02 USD
Sources of income = sum of income sources (e.g. small business, sell of crop/animal products, etc.)

As shown in Table 4, the average age of the respondents was 42 years, and most of the women fell into the 30-49 years category. In 2019, the median age in Ethiopia was 19.5 (UNDP 2019), and the life expectancy at birth was 66.6 years, which was higher than the mean in Sub-Saharan Africa, which was 61.5 years in 2019. Between 1990 and 2019, Ethiopia's life expectancy at birth increased by 19.5 years (UNDP 2020). The life expectancy at birth for male was 64 years and for female 70 years in 2022. Age division in Ethiopia was 39 percent for age group 0-14 years, 58 percent for group 15-64, and 65 plus years stand for 3 percent in 2022 (UNFPA 2023).

According to the data collected in this survey, about half of the women have completed primary education, and 18 percent have completed secondary education. The average length of schooling was 4.7 years. According to UNDP (2019), the schooling length of our respondents was considered high compared to the average schooling length of 2.9 years in Ethiopia in 2019, but was also lower than the average schooling length of 5.8 years in Sub-Saharan Africa in the same year. Between 1990 and 2019, the mean years of schooling increased by 1.4 years (UNDP 2020). Not only for women, but all over the world, education is one of the most important aspects of social and economic development. Education improves capabilities and is strongly associated with various socioeconomic variables such as income, lifestyle, and fertility for both individuals and society (EPHI & ICF 2021). Girls and women who get an education are less likely to marry young and more likely to lead healthy and productive lives. They earn higher incomes, participate in the decisions that affect them most, and build better futures for themselves and their families. Educating girls and women strengthens the economy and reduces inequality. It contributes to more stable and resilient societies that give all individuals - including boys and men - the opportunity to fulfil their potential (UNICEF 2023). In Ethiopia, more than half of the adult population is illiterate, which is consistent with the results of this study, where nearly a one-third of respondents had not attained any education. According to UNDP (2019) the adult literacy rate was 51.8 percent in 2019. The blame lies on a lack of schools, unqualified teachers, a poor-quality theoretical curriculum, and a lack of teaching aids (People in Need 2022). From 2010 till 2022, 78 percent of Ethiopians reached primary education, 53 percent reached secondary education and 26 percent reached upper secondary education (UNFPA 2023).

As a result of this survey, only two major religions were present, 80 percent of the women were Protestant, and almost 20 percent were Orthodox. This is in line with the International Religious Freedom Report (2020), where established Protestant churches have had the highest number of adherents in the SNNPRS and Gambella regions and parts of the Oromia region in recent years. At the time of the 2007 census, the religion of Ethiopia was classified under six categories (Orthodox, Protestant, Catholic, Muslim/Islam, traditional, and others). 43.5 percent of the total population was Orthodox Christian, 33.9 percent was Muslim, and 18.6 was Protestant (CSA 2008). Nowadays, most observers believe that the proportion of Evangelicals and Pentecostals in the population has increased since the census. Orthodox is predominant in the northern

regions of Amhara and Tigray, while Islam is most prevalent in Afar, Somali, and Oromia regions. Groups that together make up less than five percent of the population include Eastern Rite and Roman Catholics, members of The Church of Jesus, Christ of Latter-day Saints, Jehovah's Witnesses, Jews, and followers of indigenous religions. The Rastafarian community has approximately 1,000 members, and its members live mainly in Addis Ababa and the town of Shashemene in the Oromia region (International Religious Freedom Report 2020).

Within the scope of this survey, the number of married women was high, reaching almost 90 percent of respondents. The number of divorced women was significantly lower, accounting for 4 percent of women and 7 percent were widows. The high number of married women is consistent with Ethiopian statistics, which show that Ethiopia has one of the highest rates of early marriage in the world: one in two girls marries before the age of 18 and one in five before the age of 15. In general, marriage at an early age also increases the social and economic insecurity of girls, women and families. In Ethiopia, girls married before the age of 15 are more likely to be illiterate and less likely to be enrolled in school. In 2005, only 12 percent of married women aged 15-19 were enrolled in school, compared to 60 percent of women aged 15-19 who were not married and did not have a child (PRB 2011). According to case studies from Ethiopia by Dagnew et al. (2020), predictors of divorce were primarily age at marriage, employment status, partner abuse, globalization, sexual satisfaction, and economic problems.

In terms of household characteristics, according to results presented in Table 4, the average household size was 5.4 members, which was higher than the results of the study in 2019 done by EPHI and ICF (2021), with an average household size of 4.7 members in Ethiopia. Compared with the study of DHS (2000) in 1994, the average household size in Ethiopia was 4.8 members per household, and according to United Nations (2017), in 2011, it was 4.6 members per household. So, the size has not changed significantly over the years. Ethiopia stands with average household size in the middle in comparison with its neighbours – South Sudan 5.9, Somalia 5.9, Kenya 3.9, and Uganda with 4.7 members per household (United Nations 2017).

The households of respondents in this survey were predominantly headed by men (84 percent), but some households were also headed by women (16 percent). These results

were consistent with the EPHI and ICF (2021) study, where Ethiopian households were male-headed at 78 percent and female-headed at 22 percent.

As part of this survey, women's sources of income were identified. The main source of income for more than 50 percent of respondents was the sale of crops and crop products, while the sale of live animals and livestock was the main source of income for only 16 percent of women. A quarter of the respondents ran their own small business (e.g. bakery, hairdresser, grocery shop, etc.). Finally, 4 percent of women had government/retirement benefits, and 3 percent had wages/salaries. Most women (88 percent) had two or fewer sources of income, while the remainder (22 percent) combined three or more sources of income. The main sources of income of women respondents in this study were consistent with the study by Abate et al. (2022), where 83 percent of smallholder farmers in Ethiopia were engaged in agricultural activities and only 27 percent in non-agricultural/non-farm economic enterprises. Adem et al. (2018) stated that non-farm employment provides farmers with additional income that allows them to spend more on basic human needs. Therefore, the number should be higher in the future, not only in relation to respondents in this study.

This survey identified four main sources of information on new dietary practices. For almost half of the respondents, getting information from extension workers was the most important. An extension worker is defined as a professional who provides education, training and assistance to communities or individuals, usually in the context of agriculture or rural development. The second most used source of information was family and friends (28 percent), followed by the health centre (14 percent). The media served as the main source of information for 8 percent of women and information from a project called "Arba Minch Fruit Value Chain, Gamo zone, SNNPR, Ethiopia" implemented in Arba Minch was the main source for 4 percent of women. Reinhardt and Fanzo (2014) confirmed the same results in their study, where the source of knowledge (such as food safety, nutrient content, potential health benefits, and practical aspects such as ease of preparation and availability) played a major role in the quality of respondent’s diets.

In the case of respondents of this study, 74 percent of women did not have credit, while the rest (26 percent) of women did. The low number of female credit holders is consistent with a 2017 study done by Bessir (2018), which found that access to consumer loans and credit was very low in Ethiopia compared to other countries. Despite growth in

recent years, Ethiopia still lags behind other countries in Sub-Saharan Africa. In Kenya, for example, 82 percent of adults have an account, while in Rwanda 50 percent of the population has an account (Bessir 2018). The FSD (2022) study conducted in Ethiopia in 2017 found that the proportion of adults with an account was 35 percent, compared to 22 percent in 2014. Differences in account ownership between men and women were observed. In 2017, 41 percent of males and 29 percent of females had an account, while in 2014 account ownership was about the same, with 23 percent of males and 21 percent of females having an account. In general, women, rural adults, the less educated, the unemployed, and the poor are less likely to own an account (FSD 2022). Mukasa et al. (2017) also report that owning a credit account can help increase farmers' purchasing power to obtain needed inputs and, in the long run, can improve farmers' ability to make profitable investments.

The data in Table 4 indicates the proportion of livestock in the households of our respondents, with chickens (n=566) representing the highest number of livestock in respondents' households, followed by cows and calves (n=216), oxen (n=127) and donkeys (n=31). The average number of livestock per household was 6.5 animals. Livestock per household varied, ranging from 0 animals per household to a maximum of 39 animals per household. Of the livestock kept by respondents of this study, chickens (46 percent) served as a source of income, followed by cows (34 percent), goats (23 percent), sheep (18 percent), oxen (14 percent) and donkeys (3 percent). Muema et al. (2023) reported that livestock breeding was beneficial for women. Livestock breeding can be a major source of animal protein or increase the diversity of production and consumption. Other benefits can be increased household income levels through trade in livestock and livestock products, leading to improved household diets, women's empowerment through greater socioeconomic influence on household decisions on food distribution within the household or decisions on food and health expenditure, and improved productivity through crop-livestock interaction by providing field manure and draught power. The study by ILRI (2022) reported that Ethiopia had the largest number of livestock in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens, which could be beneficial for the poverty reduction of Ethiopians in the coming years.

According to the results of this survey, 70 percent of women grew bananas and mangoes in their homegardens, while 23 percent grew limes, maize and avocados. Coffee, cassava and teff were grown by 10 to 15 per cent of women's households. Less than 10 percent of women grew moringa, papaya, gistha, haricot beans, tomatoes, lemon, cotton and sweet potatoes. It was found that banana was the most common source of income for 71 percent of women, followed by mango (31 percent). Maize and cassava were behind less than 8 percent of income provision. Cotton, tomatoes, teff, haricot beans, coffee and papaya were the least sold. In the case of the survey conducted, there were no more than 16 crops per household. Diversity groups of 0-5 and 6-10 crop species per household were similar in size, with approximately 50 percent of respondents in each group. The diversity of crop species grown by respondents of this study was relatively low compared to the study by Kebebew (2018), who reported the availability of 138 species in homegardens in Arba Minch, with Fabaceae being the most common group of plants. According to Mengistu et al. (2021), crop diversification has a positive impact on household food security, with more crops being grown in the household, which increases food security.

4.1.2. WDDS

Table 5 demonstrates the percentage of food groups consumed by respondents of this study. The range of dietary score was from 2 to 5 food groups with a mean WDDS of 3.9, with 70 percentage of women consuming four food groups per day. According to a study conducted by SNNP Region (2020) set a minimum for women to consume 5 food groups per day for adequate food intake, while less than 5 food groups per day was considered insufficient dietary diversity and food insecurity. Comparing to this recommendation, only 13.5 percent respondents achieved the recommended minimum dietary diversity within 24 hours. Alamirew et al. (2023) reported a similar result in their study conducted in the Amhara region, where the majority of women (73.2 percent) did not achieve the minimum dietary diversity (mean 4). On the other hand, the results of Merga et al. (2022) from the West Shoa zone in Ethiopia were not consistent with the results of this study, where the proportion of women who consumed more or the same as five food groups was 81.9 percent.

Of the data collected, a total of 8 women responded that they did not receive an adequate diet, even though they wanted to, for a specific reason. Three women suffered

at all meals (breakfast, lunch and dinner), one of the women twice a day (lunch and dinner), and the rest once a day. The main reasons for insufficient feeding were (i) lack of money to buy food, (ii) lack of food in the household, and (iii) a combination of both.

Table 6 Percentage of number of food groups consumed (n=145)

Number of food groups consumed	Percentage
2	2%
3	13%
4	70%
5	**14%**

4.1.2.1. Analysis of food consumed

In the survey, each woman participant followed a diet consisting of three primary meals daily: breakfast, lunch, and dinner. Only one participant included an afternoon snack in her diet, while morning snacks were absent in all cases. The entirety of participants (100 percent), incorporated at least one serving of coffee into their daily consumption habits, with some individuals also consuming tea or milk. Figure 5 shows the limited variety of food items in the participants' diet, which includes only 14 different items. Predominant foods of the female participants' diets included kitcha, fosesse, moringa, kurkufa, and injera. Notably, kitcha and fosesse were consumed by nearly 80 percent of the participants throughout the day. Additionally, bananas emerged as the sole representation of fruit, accounting for consumption by 13 percent of women. All recipes accompanied by illustrations can be found in Appendix 2.

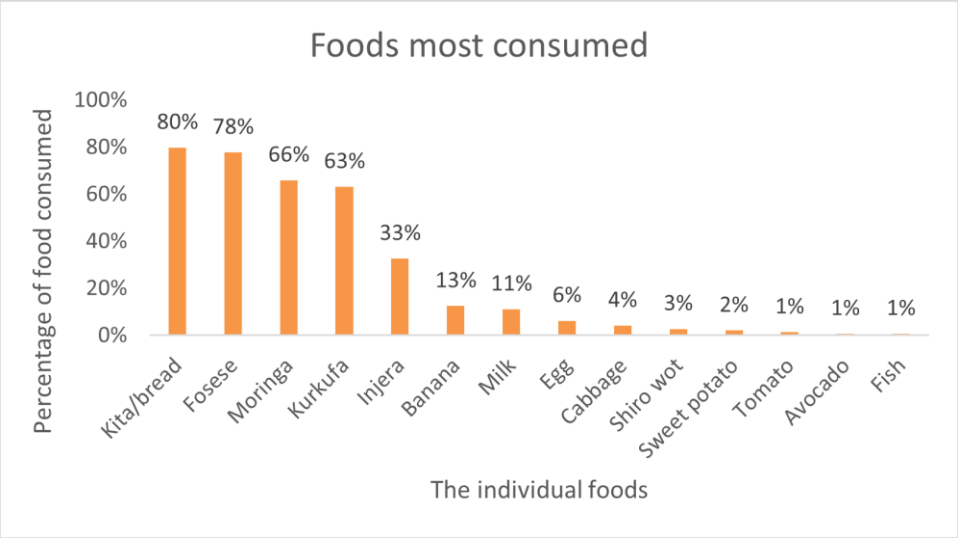

Figure 5 Most consumed foods (n=145)

4.1.2.2. Analysis of food groups consumed

Table 6 presents an analysis of the dietary diversity scores, including nine food groups consumed by the respondents. With the exception of organ meats, all other groups were represented in the responses. Starchy staple foods were overwhelmingly consumed (100 percent), followed by dark green leafy vegetables (100 percent), other fruits and vegetables (97 percent), and legumes, nuts, and seeds (79 percent). The raised consumption of these food groups primarily stemmed from the prevalence of commonly consumed foods such as moringa, kitcha, injera, and fossese, which are integral components of the food groups mentioned above. Table 7 provides a breakdown of the 14 distinct foods reported in the responses, categorized according to their respective food groups.

In line with this research, findings from studies conducted by Workicho et al. (2016) and Gali et al. (2017) in the northern part of Ethiopia and Jimma zone indicated a prevalent consumption of cereal-based diets over animal source foods. Similarly, a study conducted in the Oromia region of Ethiopia yielded comparable results, with a high proportion of respondents consuming cereals (96.4 percent), alongside notable consumption of dairy products (84.3 percent), a contrast to our study where dairy consumption was relatively low (Aliyo et al., 2022). Additionally, research conducted in the Amhara region confirmed the widespread consumption of starchy staples among WRA, followed by pulses within the food group of "legumes, nuts, and seeds". However, the consumption of dark green leafy vegetables was notably lower in this region (10.2

percent), probably due to reduced intake of moringa leaves (Alamirew et al., 2023), which are very popular in the study area. The lower dietary diversity observed in these contexts underscores the significant problem posed by the predominant reliance on starchy foods in the Ethiopian diet (Melaku et al., 2018).

Table 7 Percentage of consumption for each food group (n=145)

Number of food group	Name of food group	Percentage
1	Starchy staples	**100%**
2	Dark green leafy vegetable	**100%**
3	Other vitamin A rich fruits and vegetables	2%
4	Other fruits and vegetables	**97%**
5	Organ meat	0%
6	Eggs	6%
7	Legumes, nuts, and seeds	**79%**
8	Milk and milk products	11%
9	Meat and fish	1%

Table 8 Individual ingredients belonging to food groups (n=145)

Number of food group	Name of food group	Meals with ingredients
1	Starchy staples	Kitcha (wheat flour), Fossese (maize flour, potato), Kurkufa (cornflour), Injera (teff flour)
2	Dark green leafy vegetable	Fossese (moringa leaves), Kurkufa (kale), cabbage
3	Other vitamin A rich fruits and vegetables	Sweet potato
4	Other fruits and vegetables	Fossese (onion), Kurkufa (onion, garlic), banana, tomato, avocado
5	Organ meat	
6	Eggs	Eggs
7	Legumes, nuts, and seeds	Kurkufa (red kidney beans), Shiro wot (chickpea)
8	Milk and milk products	Milk
9	Meat and fish	Fish

4.1.2.3. Statistical analysis of WDDS and variables

After applying the binary logistic regression, significant positive correlations were found between the WDDS and independent variables presented in Table 8 below. Significant positive correlations were found between WDDS and source of information ($p<0.01$), age; groups 40-49 years ($p<0.047$) and 50+ years ($p<0.039$), and marital status ($p<0.039$). The number of livestock in the household (10-15 animals) was considered highly significant ($p<0.01$).

According to the findings presented in Table 8, survey respondents who draw information from a wider range of sources (3-4 sources) exhibit a 20.8 times increase in the likelihood of achieving food security compared to those who rely on fewer information outlets (1-2 sources). This observation was confirmed by studies conducted by Halala Handiso et al. (2020) and Nkoko et al. (2023), which similarly highlighted the positive association between accessing multiple information channels and food security outcomes. In addition, Halala Handiso et al. (2020) emphasized the importance of diversifying information sources and stated that such an approach enables women to make informed decisions regarding agricultural practices, market dynamics and health. This, in turn, contributes to greater resilience, improved well-being and greater dietary diversity.

The results presented in Table 8 show a positive correlation between WDDS and the presence of livestock in the households of respondents. Specifically, households owning between 10-15 animals demonstrated an approximately 50 times increase in the likelihood of achieving food security compared to those with fewer livestock holdings. However, the precise impact of owning 15 or more livestock could not be ascertained due to the limited frequency of responses in this category. These results aligned with the conclusions drawn from the study conducted by Aliyo et al. (2022), which emphasized a positive relationship between enhanced dietary diversity and increased livestock ownership within households. Furthermore, Aliyo et al. (2022) asserted that this association underscores the connectivity among livestock ownership, nutritional intake, and food security. Moreover, Hetherington et al. (2017) contributed to the findings by highlighting the multifaceted benefits of livestock ownership in households. They reported that a higher number of livestock holdings can augment dietary diversity among women through various mechanisms. These include the provision of direct sources of protein and micronutrients, generating additional income for the purchase of a wider

range of foods, and aligning with cultural practices that enhance the nutritional quality and cultural significance of diets.

According to the results of this study, a significant association was found between the age of women and WDDS, particularly within the age groups of 40-49 years and 50+ years. Specifically, women over the age of 40 were more likely than their younger counterparts to achieve adequate dietary diversity. This finding was consistent with research conducted by Gitagia et al. (2019) in Northern Kenya and Nkoko et al. (2023) in Lesotho, which similarly observed a positive correlation between older age and improved dietary diversification among women. According to the findings of these studies, several factors contributed to the higher dietary scores observed among older women. These factors included accumulated knowledge about food and nutrition, adherence to traditional dietary practices, influential role in household decision-making processes, economic stability, and long-term exposure to food security issues. This suggests that the dietary choices of older women were influenced by a complex combination of cultural, economic, and generational factors.

Further, the results in Table 8 indicate the positive correlation between WDDS and marital status, with divorced and married women demonstrating a higher probability of reaching food security than widowed women. This observation was in line with the conclusions drawn by Djuikom and Walle (2022) and Weil et al. (2023), who highlighted the challenges met by divorced women in terms of food insecurity. Following divorce, women often experienced the loss of economic resources and support acquired during marriage, including access to productive assets like farmland. However, divorce also offered potential benefits, such as heightened control over resources, economic autonomy, and access to supportive networks. Conversely, marriage was associated with improved food security, as evidenced by the studies conducted by Djuikom and Walle (2022) and Weil et al. (2023). In Africa, marriage typically facilitated greater dietary diversity due to resource sharing between husbands, collaborative meal preparation, support from extended family networks, the integration of diverse cultural culinary practices, and enhanced economic stability. These factors collectively contributed to a more varied and nutritious diet among married individuals.

Table 9 Association of WDDS with independent variables (n=145)

Variable	B	Wald	Sig.	Exp(B)
Source of information (3-4)	3.036	6.654	0.010*	20.814
Source of food	1.058	1.433	0.231	2.879
Sources of income	-5.134	2.257	0.133	0.006
N. of crops in HG	1	3.293	0.193	1
N. of livestock in HH				
0-5	1	7.79	0.051	1
6-10 animals	1.328	0.938	0.333	3.772
11-15 animals	3.847	7.665	0.006**	46.839
15+ animals	-14.645	0	0.999	0
Food expenditure per month	0.111	0.013	0.909	1.117
Level of education	1	0.203	0.904	1
Household size	1.458	2.319	0.128	4.299
Age				
20-29	1	7.166	0.067	1
30-39	0.675	0.304	0.581	0.509
40-49	3.026	3.956	0.047*	0.049
50+	3.501	4.255	0.039*	0.03
Household assets	-0.021	0.001	0.979	0.979
Sex of household head	-2.181	2.147	0.143	0.113
Marital status				
Divorced	1	6.468	0.039*	1
Married	7.592	6.468	0.011*	0.001
Widowed	22.154	0	0.998	0
Access to credit	-0.291	0.094	0.759	0.747
Religion	1.492	1.847	0.174	4.446

1 = reference category, p<0.05*, p<0.01**

4.1.2.4. 24HR

The data presented in Table 9 explains the proportion of kilocalories obtained by our participants on a daily basis. It was observed that only 13 percent of respondents achieved the recommended minimum daily intake of 2,000 kcal. The recorded kcal intake ranged from a minimum of 600 kcal/day to a maximum of 2,500 kcal/day, with an average intake of 1,345 kcal/day. Notably, the kcal intake recorded in our study significantly contrasts with the recommended per capita energy consumption outlined by Sheehy and Sharma (2013). Their analysis indicated a historical trend of kcal intake, which decreased from 1,710 kcal/day in 1961 to 1,403 kcal/day by 1973, before rising to 2,111 kcal/day in 2011. Conversely, Bekele et al. (2023b) estimated a daily energy intake of 2,000 kcal for adult women, a value which we defined as sufficient dietary intake in our study,

aligning with the recommendations for WRA. Furthermore, the Federal Government of Ethiopia (2022) defined three energy levels categorised according to specific subpopulation diets: low (1,250 kcal/day for preschool children aged 2-5 years), medium (2,300 kcal/day for school-age children aged 6-18 years and older individuals aged 65 years and above), and high (2,700 kcal/day for adult men and women aged 19-64 years). The majority of respondents in our study reached energy intakes corresponding to the energy intakes of preschool children aged 2-5 years according to the three energy levels.

Table 10 Kcal intake per day (n=47)

Kcal intake per day	Percentage
<1000	27%
1001-2000	60%
2001+	**13%**

4.2. FGD

According to the focus group discussion results, for most participants, the main daily meals were breakfast, lunch and dinner. About snacks, individual habits were given. *"I usually eat a snack, but always in the afternoon, around 3 pm.". "For snack, I eat mostly moringa or fossese",* stated another woman. Some women disagreed, *"I am not used to eating snacks at all.".* For all meals per day, the ingredients were mostly similar. The women reported that they mainly eat bread/kitcha with moringa (halako) for breakfast. They usually eat fossese, kurkufa, or sometimes boiled cabbage for lunch. Some participants explained, "*if I prepare recipe 1. for lunch (e.g. fossese), I prepare recipe 2. for dinner (e.g. kurkufa).*". "*Maize is the main ingredient in our recipes; mostly, I cook halako, kurkufa or fossese"*. Some women mentioned adding false banana or Irish potatoes to their porridges. Injera is only eaten occasionally, often at certain ceremonies.

Meat, fish, milk and dairy products are consumed occasionally. *"The frequency of meat and dairy consumption depends mainly on the household's wealth, as buying a cow, for example, is expensive*", stated some women. Other respondent agreed, *"households without cows consume milk and eat meat mainly during ceremonies, as Easter, New Year, and Bonfire (Demera)"*. Milk is used in porridge dishes instead of water, and cheese is usually eaten with kitcha and shared with children. The women

agreed that fish is also expensive, so the frequency depends on wealth; they usually eat it once a month.

In the case of fruit and vegetables, women agreed that they eat fruit frequently. *"Consumption of fruit depends mainly on the season; at harvest time, I eat fruit daily"*. Another woman added, *"I eat fruit every day or every two days"*. The most commonly consumed fruits were papaya, avocado, mango and banana. Among vegetables, cabbage, tomatoes, carrots and potatoes were the most commonly consumed. In the case of some cooperatives, the purchase of vegetables is only possible at markets and depends on the time of production. Another factor is the availability of some varieties in the markets, *"for example, we sometimes have to go to the highlands for beetroot and cabbage"*.

Not only markets but also home gardens and fields are sources of food. Respondents agreed that the most commonly grown species in their home gardens and fields are mango, moringa, teff, coffee, lemon, papaya, banana and maize. Not all women in the discussion had home gardens; if they did, the average land size was around 0.5 hectares. If they did not have a home garden, some female respondents stated, *"we can use the fields for food, these fields are owned by the state"*. Another respondent added, *"yes, we can use our fields, but it is about an 8 km walk to the fields, it takes over an hour."*. Not only are home gardens and fields a source of food, but they are also a source of income for most women. *"Most of the production is for the market". "If the maize production is low, I plant bananas. After I sell bananas, I can offer maize."*

If they had more money, most women preferred to buy mainly teff, wheat, false bananas and chicken. They also cited rice, millet or cassava as important foods. The main reasons for these foods were to diversify the diet and to taste good. The unavailability of more frequent purchases of these foods was mainly due to the high price of each item. Some women said, *"I would like to buy teff because it is very tasty and I can prepare different recipes with it, but the price is unaffordable for me"*. Another woman added: *"we eat maize all the time, I would like to buy teff or wheat to have something different"*. Another woman agreed: *"if I have maize or teff, I can prepare different recipes, and importantly, I can also prepare larger portions"*. The discussion also mentioned income: *"if we had more money, we would like to buy more types of food, sell some of it after sowing and create an income"*.

5. Conclusion

According to the Ethiopian report, more than 15.4 million people were projected to be food insecure in the second half of 2023, mainly due to various shocks, including conflict and the negative impacts of drought from previous agricultural seasons in Ethiopia (OCHA 2024). Women and men play key and distinct roles in maintaining all four pillars of food security, with women primarily responsible for the nutritional security of their households. On the other hand, compared to men, women are globally more vulnerable to food shortages, food insecurity and death due to malnutrition. In upper-middle and high-income countries, women are even more at risk of being overweight or obese (FAO 2024). Dietary diversity is crucial for the health of women in Ethiopia, impacting their nutritional well-being, particularly during important life stages such as pregnancy and lactation. Inadequate diversity in diets can lead to micronutrient deficiencies, affecting maternal and child health outcomes (Jateno et al. 2023).

This survey focused on the dietary habits of 145 female respondents, aged between 21 and 60 (with a mean age of 42 years), from three kebeles in the Arba Minch Zuriya district, Gamo Gofa zone, SNNPR, Ethiopia, namely Chano Doriga, Chano Mile, and Chano Cheliba. The average length of schooling for the respondents was 4.7 years, which was considered higher than the Ethiopian average from 2019. Additionally, the respondents' household size was higher than the average in Ethiopia in 2019, with an average of 5.4 members per household. The majority of the women (81.6 percent) were Protestants, while the rest were Orthodox. Dietary diversity was measured using the Women Dietary Diversity Score, revealing that the majority of respondents did not reach the recommended minimum consumption of 5 food groups per day. On average, women consumed 3.9 food groups per day, with 70 percent consuming 4 food groups per day. Only 14 percent of women reached the recommended minimum for women of reproductive age. All women consumed three main meals per day (breakfast, lunch, and dinner), and most also had at least one cup of coffee per day, with some also consuming milk or tea. Eight women reported being unable to consume the amount of food they desired, primarily due to a lack of money, insufficient food in the household, or a combination of both reasons. The most consumed food groups were starchy staples and dark green leafy vegetables, both consumed by 100 percent of respondents. High consumption was also observed in the fruits and vegetables food group (97 percent) and

legumes (79 percent). The remaining five food groups, such as meat and fish, milk and milk products, eggs, organ meat, and other vitamin A-rich fruits and vegetables, were consumed minimally.

The increased consumption of the most consumed food groups was mainly due to the routine consumption of meals such as kurkufa, kitcha, fossese, injera, and moringa. Caloric intake was successfully measured for 47 respondents using a 24-hour Dietary Recall. The average calorie intake was 1,345 kcal per day, which corresponds to the calorie intake of preschool children aged 2-5 years. Only 13 percent of respondents reached the recommended minimum of 2,000 kcal per day or more. According to focus group discussions with six voluntary women participants, the main reason for insufficient dietary habits was the wealth status of the household. Women expressed a desire to consume more diversified foods but explained that they often preferred to sell the products they bred or planted in the market to generate income rather than consume them. Another issue mentioned was the limited availability of diversified foods in the market, with some flavorful products only being available in the highlands. Some women also mentioned that wealthier households often raised cows and consumed meat often, while poorer families mainly consumed meat products during ceremonies. According to binary logistic regression, significant positive correlations were found between WDDS and the number of information panels, the age of respondents, marital status, and the number of livestock in households.

A limitation of this study was the lack of 24 HR data collection. Despite sufficient training and a pilot test of 24HR data collection, collectors collected only one-third of the data adequately.

In conclusion, understanding the socio-cultural factors influencing dietary behaviour is essential to address all the problems and improve the overall health status of women not only in this region but in Ethiopia as a whole. It is important that local and international efforts come together to provide emergency assistance, restore normalcy to the affected communities and work towards improving the food security of the population in the future.

6. References

Abate GT, Bachewe FN, Minot RN. 2022. Rural Income Diversification in Ethiopia. IFPRI Discussion Paper 02154. DOI: https://doi.org/10.2499/p15738coll2.136494.

Adem M, Tadele E, Mossie H, Ayenalem M. 2018. Income diversification and food security situation in Ethiopia: A review study. Cogent Food and Agriculture **4**:1–17.

Advent Health. 2023. Health Benefits of Magnesium. Available from https://www.adventhealth.com/blog/health-benefits-magnesium.(accessed March 2024).

Ahmed T, Hossain I, Munirul I, Ahmed S, Farzana A, Christi J. 2020. Protein-Energy Malnutrition in Children. Pages 1034–1041 Hunter's Tropical Medicine and Emerging Infectious Diseases.

Akram M, Munir N, Daniyal M, Egbuna C, Găman M-A, Onyekere PF, Olatunde A. 2020. Vitamins and Minerals: Types, Sources and their Functions. Functional Foods and Nutraceuticals **66**:149–172.

Alamirew SK, Lemke S, Stadlmayr B, Freyer B. 2023. Dietary Behaviour and Sociocultural Determinants of Dietary Diversity among Rural Women of Reproductive Age: A Case of Amhara Region, Ethiopia. Nutrients **15**.

Aliyo A, Golicha W, Fikrie A. 2022. Household Dietary Diversity and Associated Factors among Rural Residents of Gomole District, Borena Zone, Oromia Regional State, Ethiopia. Health Services Research and Managerial Epidemiology **9**:1–8.

Amente G, Dione O. 2024. Unlocking Opportunities: Leveraging Livestock and Fisheries Development for Inclusion, Prosperity, and Peace in Ethiopia. Available from https://blogs.worldbank.org/africacan/unlocking-opportunities-leveraging-livestock-and-fisheries-development-inclusion-afe-0124. (accessed March 2024).

Bailey RL. 2021. Overview of dietary assessment methods for measuring intakes of foods, beverages, and dietary supplements in research studies. Current Opinion in Biotechnology **70**:91–96.

Baltic MZ, Boskovic M. 2015. When Man Met Meat: Meat in Human Nutrition from Ancient Times till Today. Procedia Food Science **5**:6–9.

Bante A, Mersha A, Zerdo Z, Wassihun B, Yeheyis T. 2021. Comorbid anxiety and depression: Prevalence and associated factors among pregnant women in Arba Minch zuria district, Gamo zone, southern Ethiopia. PLoS ONE **16**:1–15.

Barber TM, Kabisch S, Pfei AFH, Weickert MO. 2020. Nutrients-12-03209.Pdf. Nutrients **12**:1–17.

Bath S, Pettitt C. 2022. Iodine. Available from https://www.bda.uk.com/resource/iodine.html. (accessed March 2024).

Bekele TH, Trijsburg L, Brouwer ID, de Vries JH, Covic N, Kennedy G, Alemayehu D, Feskens EJ. 2023a. Dietary Recommendations for Ethiopians on the Basis of Priority Diet-Related Diseases and Causes of Death in Ethiopia: An Umbrella Review. Advances in Nutrition **14**:895–913.

Bekele TH, Van Rooijen M, Gerdessen JC, Brouwer ID, Feskens EJM, Trijsburg L, Alemayehu D, De Vries JHM. 2023b. Developing feasible healthy diets for Ethiopian women of reproductive age: a linear goal programming approach. Public Health Nutrition **26**:2096–2107.

Bessir M. 2018. Financial inclusion in Ethiopia: 10 takeaways from the latest Findex. Available from https://blogs.worldbank.org/africacan/financial-inclusion-in-ethiopia-10-takeaways-from-findex-2017. (accessed March 2024).

Blake S. 2007. Vitamins and Minerals Demystified. McGraw-Hill.

Boehringer Ingelheim. 2023. Kardiovaskulární onemocnění. Available from https://www.boehringer-ingelheim.com/cz/lidske-zdravi/kardiovaskularni-onemocneni. (accessed March 2024).

Bowen K, Sullivan V, Etherton P, Petersen K. 2018. Nutrition and Cardiovascular Disease-an Update. Coronary Heart Disease **20**:9.

Brinkhoff T. 2022. Arba Minch. Available from https://www.citypopulation.de/en/ethiopia/admin/southern/ET071021__arba_minch/. (accessed March 2024).

British Red Cross. 2023. Africa food crisis: more than 150 million people are going hungry. Available from https://www.redcross.org.uk/stories/disasters-and-emergencies/world/africa-hunger-crisis-100-million-struggling-to-eat. (accessed

March 2024).

Busse H, Kurabachew H, Ptak M, Fofanah M. 2017. A food-based approach to reduce Vitamin A deficiency in Southern Ethiopia: A cross-sectional study of maternal nutrition and health indicators. African Journal of Food, Agriculture, Nutrition and Development **17**:12226–12242.

Centre for Food Safety. 2023. Iodine in Food. Available from https://www.cfs.gov.hk/english/programme/programme_fii/programme_fii.html. (accessed March 2024).

CGIAR. 2023. The Ethiopian food-based dietary guidelines: Gamechanger for food system transformation? New project note from SHiFT. Available from https://www.cgiar.org/news-events/news/the-ethiopian-food-based-dietary-guidelines-gamechanger-for-food-system-transformation-new-project-note-from-shift/. (accessed March 2024).

Climate Data. 2023. ARBA MINCH CLIMATE. Available from https://en.climate-data.org/africa/ethiopia/southern-nations/arba-minch-3066/. (accessed March 2024).

CLOSER. 2024. Dietary assessment tools (DATs). Available from https://closer.ac.uk/cross-study-data-guides/dietary-data-guide/dietary-assessment-tools/. (accessed March 2024).

Cobalt institute. 2023. Cobalt in medicine. Available from https://www.cobaltinstitute.org/essential-cobalt-2/health-wellbeing/. (accessed March 2024).

CSA (Central Statistics Authority). 2008. Summary and Statistical Report of the 2007 Population and Housing Census. Open Access Library Journal **8**.

Dagnew GW, Asresie MB, Fekadu GA, Gelaw YM. 2020. Factors associated with divorce from first union among women in Ethiopia: Further analysis of the 2016 Ethiopia demographic and health survey data. PLoS ONE **15**:1–12.

Dao MC, Subar AF, Warthon-Medina M, Cade JE, Burrows T, Golley RK, Forouhi NG, Pearce M, Holmes BA. 2019. Dietary assessment toolkits: An overview. Public Health Nutrition **22**:404–418.

Das P, Pooja. 2021. Chapter 13 - Fluorine: Risk assessment, environmental, and health hazard. Pages 153–167 Hazardous Gases. Haridwar.

DATA P. 2023. Ethiopia Climate and Agriculture. Available from https://www.prepdata.org/stories/ethiopia-climate-and-agriculture. (accessed March 2024).

DHS. 2000. HOUSEHOLD POPULATION AND HOUSING CHARACTERISTICS. Population (English Edition) **2**:9–23.

DHS. 2011. Ethiopia Out of School Children of the Population Ages 7-14. Demographic and Health Survey **4**:3–7.

Dietitians of Canada. 2015. Food Sources of Calcium. Government of Canada:1–3.

Djuikom MA, Walle D van de. 2022. Marital status and women's nutrition in Africa. World Development **158**.

Dorwart L. 2023. What Is Selenium? Available from https://www.health.com/selenium-benefits-8357334. (accessed March 2024).

Embassy of Ethiopia. 2022. ABOUT ETHIOPIA. Available from https://ethiopianembassy.org/overview-about-ethiopia/. (accessed March 2024).

Engel P. 2010. Beta-Carotene AT A GLANCE Introduction. Nutri-facts **1**:1–4.

EPHI, ICF. 2021. Ethiopia Mini Demographic and Health Survey 2019: Final Report **2**:1–207.

Ethiopian Public Health Institute (EPHI), World Food Programme (WFP). 2020. Cost and affordability of nutritious diets in Ethiopia **2**:2–5.

Fajfrová J. 2011. Vitaminy a jejich funkce v organizmu. Interni Medicina pro Praxi **13**:466–468.

Fajfrová J, Pavlík V. 2013. Vitaminy, jejich funkce a využití. Medicína pro praxi **10**:81–84.

FANTA F and NTAIP. 2016. Minimum Dietary Diversity for Women (MDD-W). Food and Agriculture Organization of the United Nations. Available from https://www.fantaproject.org/monitoring-and-evaluation/minimum-dietary-diversity-women-indicator-mddw. (accessed March 2024).

FAO/WHO Expert Consultation. 2005. Human Vitamin and Mineral Requirements. Geneva : World Health Organization **25**:341.

FAO. 2001. DEFINITION AND CONCEPT OF HOME GARDENS IN AFRICA. IMPROVING NUTRITION THROUGH HOME GARDENING. Roma.

FAO. 2005. Human energy requirements: report of a joint FAO/ WHO/UNU Expert Consultation. Food and nutrition bulletin **26**:166.

FAO. 2009. Vitamin A deficiency. Available from https://www.who.int/data/nutrition/nlis/info/vitamin-a-deficiency. (accessed March 2024).

FAO. 2017. Africa Sustainable Livestock 2050, country brief Uganda. Food and Agriculture Organization **49**:0–8.

FAO. 2022. Hunger and food insecurity. Available from https://www.fao.org/hunger/en/. (accessed March 2024).

FAO. 2024. Gender. Available from https://www.fao.org/gender/learning-center/thematic-areas/gender-and-food-security-and-nutrition/en. (accessed March 2024).

Federal Government of Ethiopia. 2022. Ethiopia: Food-Based Dietary Guidelines–2022. Federal Government of Ethiopia, Ministry of Health, Ethiopian Public Health Institute.

FEWS NET. 2021. East Africa Food Security Outlook, October 2021 to May 2022. Available from https://reliefweb.int/report/ethiopia/east-africa-food-security-outlook-october-2021-may-2022. (accessed January 2024).

FEWS NET. 2024. Ethiopia. Available from https://fews.net/east-africa/ethiopia. (accessed March 2024).

Foundation BN. 2018. Recommendations for women. Available from https://www.nutrition.org.uk/life-stages/women/nutrition-recommendations-for-women/. (accessed March 2024).

Franch C, Valls B. 2003. Marasmus. Pages 3697–3703 Encyclopedia of Food Sciences and Nutrition Encyclopedia of Food Sciences and Nutrition (Second Edition). Valencia.

FSD Ethiopia. 2022. Why Financial Inclusion Matters. Available from https://fsdethiopia.org/our-work/. (accessed March 2024).

Gali N, Tamiru D, Tamrat M. 2017. The Emerging Nutritional Problems of School Adolescents: Overweight/Obesity and Associated Factors in Jimma Town, Ethiopia. Journal of pediatric nursing **35**.

Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, Ostolaza H, Martín C. 2020. Pathophysiology of type 2 diabetes mellitus. International Journal of Molecular Sciences **21**:1–34.

Gesundheit.gv.at. 2023. Vitamin B9 (kyselina listová, folát). Available from https://www.nzip.cz/clanek/1140-vitamin-b9-kyselina-listova-folat. (accessed March 2024).

Getaneh ZA. 2019. Ethnobotanical study of traditional medicinal plant species of Arba Minch Zuriya Wereda, SNNPR, Ethiopia. Journal of Medicinal Plants Studies **7**:182–185.

Gitagia MW, Ramkat RC, Mituki DM, Termote C, Covic N, Cheserek MJ. 2019. Determinants of dietary diversity among women of reproductive age in two different agro-ecological zones of rongai sub-county, nakuru, Kenya. Food and Nutrition Research **63**:1–12.

Global Hunger Index. 2023. Ethiopia. Available from https://www.globalhungerindex.org/ethiopia.html. (accessed March 2024).

Golovinskaia O, Wang Ch. 2021. Review of Functional and Pharmacological Activities of Berries. Molecules. DOI: 10.3390/molecules26133904.

Gonzales G. 2023. Silicon: Overlooked Trace Mineral. Life Extension Magazine. Available from https://www.lifeextension.com/magazine/2003/4/report_silicon. (accessed March 2024).

Google. 2024. Google Maps. Available from https://www.google.com/maps/@6.1024393,37.5489246,13z/data=!3m1!4b1!4m3!11m2!2sjydics6iQ1q4zqxMcbIocg!3e3?entry=ttu. (accessed March 2024).

Greiner T. 2013. Vitamin A: Moving the food-based approach forward. ICN2 Expert Papers. 2nd International Conference on Nutrition “Better nutrition, better lives”

8:1–69.

Grover Z, Ee LC. 2009. Protein Energy Malnutrition. Pediatric Clinics of North America **56**:1055–1068.

Halala Handiso Y, Belachew T, Abuye C, Workicho A. 2020. Low dietary diversity and its determinants among adolescent girls in Southern Ethiopia. Cogent Food and Agriculture **6**.

Harris JK. 2021. Primer on binary logistic regression. Family Medicine and Community Health **9**:1–7.

Harter A. 2022. Carbohydrate and Exercise. Available from https://pressbooks.calstate.edu/nutritionandfitness/chapter/carbohydrate-and-exercise/. (accessed February 2024).

Health Library. 2022. Manganese. Available from https://www.mountsinai.org/health-library/supplement/manganese. (accessed March 2024).

Hejmalová M, Hrnčiříková I. 2012a. Malnutrice. Available from https://www.fsps.muni.cz/inovace-RVS/kurzy/zjistovani_vyziv_zvyklosti/1_malnutrice.html. (accessed March 2024).

Hejmalová M, Hrnčiříková I. 2012b. Zjišťování výživových zvyklostí. Available from https://www.fsps.muni.cz/inovace-RVS/kurzy/zjistovani_vyziv_zvyklosti/. (accessed March 2024).

Hetherington JB, Wiethoelter AK, Negin J, Mor SM. 2017. Livestock ownership, animal source foods and child nutritional outcomes in seven rural village clusters in Sub-Saharan Africa. Agriculture and Food Security **6**:1–11.

Hrdý P, Novosad P. 2015. Nové poznatky o funkci vitaminu D **11**:54–56.

Hrnčířová D,C Marádová E. 2018. Výživa ve výchově ke zdraví.

Hrnčířová D, Rambousková J, Blahová A, Dlouhý P, Floriánková M. 2012. Výživa a zdraví.

HRW. 2021. Ethiopia. Available from https://www.hrw.org/world-report/2022/country-chapters/ethiopia. (accessed March 2024).

Hume T. 2005. Dieta X. DONA s.r.o., České Budějovice.

IDF Diabetes Atlas. 2022. Diabetes around the world in 2021. Available from https://diabetesatlas.org/. (accessed March 2024).

INDDEX Project. 2018. Data4Diets: Building Blocks for Diet-related Food Security Analysis About Data4Diets. Available from https://inddex.nutrition.tufts.edu/data4diets.%0Ahttp://dx.doi.org/10.1016/B978-0-12-391884-0.00001-9. (accessed March 2024).

International Livestock Research Institute (ILRI). 2022. New research initiative to address challenges facing Ethiopia's dairy, poultry and small ruminants' sectors launched. Available from https://www.cgiar.org/news-events/news/new-research-initiative-to-address-challenges-facing-ethiopias-dairy-poultry-and-small-ruminants-sectors-launched/. (accessed March 2024).

International Religious Freedom Report. 2020. Ethiopia 2020 International Religious Freedom Report. United States Department of State Office of International Religious Freedom **1**:1–9.

Jateno W, Alemu BA, Shete M. 2023. Household dietary diversity across regions in Ethiopia: Evidence from Ethiopian socioeconomic survey data. PLoS ONE **18**:1–14.

Johnson L. 2023. Overview of Minerals. Available from https://www.merckmanuals.com/home/disorders-of-nutrition/minerals/overview-of-minerals. (accessed March 2024).

Kanan SOH, Swar MO. 2016. Prevalence and outcome of severe malnutrition in children less than five-year-old in Omdurman Paediatric Hospital, Sudan. Sudanese journal of paediatrics **16**:23–30.

Kebebew M. 2018. Diversity and Management of Useful Homegardens Plant Species in Arba Minch Town, Southern Ethiopia: Implication for Plant Diversity Conservation and Food Security. International Journal of Economic Plants **5**:137–148.

Kennedy G, Ballard T. DM. 2010. Guidelines for measuring household and individual dietary diversity. Fao:1–60.

Khalid SMN, Sherzad S. 2019. Agricultural Extension Manual for Extension Workers. Food and Agriculture Organization of United Nations Manual Book **3**:1–42.

Kirkpatrick S, Raffoul A. 2017. Measures Registry User Guide: Individual Diet. National Collaborative on Childhood Obesity Research. Available from http://nccor.org/tools-mruserguides/wp-content/uploads/2017/. (accessed March 2024).

Kladenský MJ. 2017. Vliv vitaminů , minerálů a stopových prvků na lidské zdraví s podrobnějším zaměřením na urogenitální systém . Jaká rizika přináší jejich deficit či předávkování ? – 1 . část **18**:58–62.

Konupková E. 2017. Kwashiorkor – příznaky, projevy, symptomy, příčina, léčba. Available from https://www.priznaky-projevy.cz/nezarazene-nemoci/1352-kwashiorkor-priznaky-projevy-symptomy-pricina-lecba. (accessed March 2024).

Laraia BA. 2013. Food insecurity and chronic disease. Advances in Nutrition **4**:203–212.

Laskowski W, Górska-Warsewicz H, Rejman K, Czeczotko M, Zwolińska J. 2019. How important are cereals and cereal products in the average polish diet? Nutrients **11**.

Mahdavi-Roshan M, Vakilpour A, Mousavi SM, Ashouri A. 2021. Dietary diversity and food security status among heart failure patients in the north of Iran. BMC Nutrition **7**:1–9.

Maris K. 2017. Enquiry. Poetry Review **107**:27–51.

Maxfield L, Shukla S, Crane J. 2023. Zinc Deficiency. Available from https://www.ncbi.nlm.nih.gov/books/NBK493231/. (accessed March 2024).

McKevith B. 2004. Nutritional aspects of cereals. Nutrition Bulletin **29**:111–142.

Melaku Y, Dirar A, Feyissa GT, Tamiru D. 2018. Optimal dietary practices and nutritional knowledge of school adolescent girls in Jimma Town, South West Ethiopia. International Journal of Adolescence and Youth **23**:299–307.

Melesse MB, van den Berg M. 2021. Consumer Nutrition Knowledge and Dietary Behavior in Urban Ethiopia: A Comprehensive Study. Ecology of Food and Nutrition **60**:244–256.

Mendivil CO. 2021. Fish Consumption: A Review of Its Effects on Metabolic and Hormonal Health. Nutrition and Metabolic Insights **14**.

Mengistu DD, Degaga DT, Tsehay AS. 2021. Analyzing the contribution of crop

diversification in improving household food security among wheat dominated rural households in Sinana District, Bale Zone, Ethiopia. Agriculture and Food Security **10**:1–15.

Merga G, Mideksa S, Dida N, Kennedy G. 2022. Dietary diversity and associated factors among women of reproductive age in Jeldu District, West Shoa Zone, Oromia Ethiopia. PLoS ONE **17**:1–11.

Mikstas C. 2022. Foods High in Sulfur. Available from https://www.webmd.com/diet/foods-high-in-sulfur. (accessed March 2024).

Moga Lencha F, Jebero Zaza Z, Ena Digesa L, Mulatu Ayana T. 2022. Minimum dietary diversity and associated factors among children under the age of five attending public health facilities in Wolaita Soddo town, Southern Ethiopia, 2021: a cross-sectional study. BMC Public Health **22**:1–10.

Molla MA, Fitsume YD. 2017. Seasonal rainfall and crop productivity in South West Ethiopia: Preliminary analysis for recent climate. International Journal of Water Resources and Environmental Engineering **9**:211–217.

Mosites E. 2016. Relations between household livestock ownership, livestock disease, and young child growth. Journal of Nutrition **146**:1118–1124.

MRC Epidemiology Unit. 2024. 24-hour dietary recalls. Available from https://www.measurement-toolkit.org/diet/subjective-methods/24-hour-dietary-recall. (accessed March 2024).

Muema J et al. 2023. The impact of livestock interventions on nutritional outcomes of children younger than 5 years old and women in Africa: a systematic review and meta-analysis. Frontiers in Nutrition **10**.

Mukasa et al. 2017. Credit constraints and farm productivity: Micro-level evidence from smallholder farmers in Ethiopia. Working Paper Series No. 247. African Development Bank Group **2**:1–40.

MUNI. 2012. Oslabení kardiovaskulárního systému. Zdravotní tělesná výchova, Fakulta sportovních studií:1–16.

Navi S. 2013. Nutrition and Health - The Importance of Potassium:1–16.

NIH. 2019. Vitamin C Fact Sheet for Consumers. U.S. National Institutes of Health.

Available from https://ods.od.nih.gov/factsheets/VitaminC-Consumer/. (accessed March 2024).

NIH. 2021a. Potassium. Available from https://ods.od.nih.gov/factsheets/Potassium-Consumer/. (accessed March 2024).

NIH. 2021b. Magnesium. Available from https://ods.od.nih.gov/factsheets/Magnesium-Consumer/. (accessed March 2024).

NIH. 2022a. Chromium. Available from https://ods.od.nih.gov/factsheets/Chromium-HealthProfessional/. (accessed March 2024).

NIH. 2022b. Copper. Available from https://ods.od.nih.gov/factsheets/Copper-Consumer/. (accessed March 2024).

NIH. 2023a. Phosphorus. Available from https://ods.od.nih.gov/factsheets/Phosphorus-HealthProfessional/. (accessed March 2024).

NIH. 2023b. Iron. Available from https://ods.od.nih.gov/factsheets/Iron-Consumer/. (accessed March 2024).

NIH. 2024. Calcium. Available from https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/. (accessed March 2024).

Nkoko N, Cronje N, Swanepoel JW. 2023b. Determinants of dietary diversity for women of reproductive age (WRA) and under-five children from small-holder farming households in Lesotho. Cogent Food and Agriculture **9**.

NZIP. 2024. Vitamin B9 (kyselina listová, folát). Available from https://www.nzip.cz/clanek/1140-vitamin-b9-kyselina-listova-folat. (accessed March 2024).

OCHA. 2024. ETHIOPIA Situation Report. Available from https://reports.unocha.org/en/country/ethiopia. (accessed March 2024).

Office for National Statistics. 2018. Measuring wealth on an individual level. Available from https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/methodologies/measuringwealthonanindividuallevel. (accessed March 2024).

Oliver M, Brevik E. 2023. Soil and human health. Pages 555–571 Encyclopedia of Soils in the Environment Encyclopedia of Soils in the Environment (Second Edition).

Osilla E, Safadi A, Sharma S. 2022. Calories. Page StatPearls Publishing. Available from https://www.ncbi.nlm.nih.gov/books/NBK499909/. (accessed March 2024).

Pal M, Molnár J. 2021. Growing Importance of Cereals in Nutrition and Healthy Life. International Journal of Food Science and Agriculture **5**:275–277.

Pem D, Jeewon R. 2015. Fruit and vegetable intake: Benefits and progress of nutrition education interventions-narrative review article. Iranian Journal of Public Health **44**:1309–1321.

People in Need. 2022. ETHIOPIA: EDUCATION AND PRACTICAL ABILITIES. Available from https://www.peopleinneed.net/what-we-do/humanitarian-aid-and-development/ethiopia/education-and-practical-abilities?_ga=2.160400893.1960187221.1649075995-828754629.1642694818. (accessed March 2024).

Porri D, Biesalski HK, Limitone A, Bertuzzo L, Cena H. 2021. Effect of magnesium supplementation on women's health and well-being. NFS Journal **23**:30–36.

PRB. 2011. Despite Challenges, Ending Early Marriage in Ethiopia Is Possible. Available from https://www.prb.org/resources/child-marriage-ethiopia/. (accessed March 2024).

Puglisi MJ, Fernandez ML. 2022. The Health Benefits of Egg Protein. Nutrients **14**.

Punthakee Z, Goldenberg R, Katz P. 2018. Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome. Canadian Journal of Diabetes **42**.

Puwanant M, Boonrusmee S, Jaruratanasirikul S, Chimrung K, Sriplung H. 2022. Dietary diversity and micronutrient adequacy among women of reproductive age: a cross-sectional study in Southern Thailand. BMC Nutrition **8**:1–11.

Reinhardt K, Fanzo J. 2014. Addressing Chronic Malnutrition through Multi-Sectoral, Sustainable Approaches: A Review of the Causes and Consequences. Frontiers in Nutrition **1**:1–11.

Robert R, John S, McCormick D. 2001. Handbook of Vitamins.

Roubík L. 2018. Moderní výživa ve fitness a silových sportech. Erasport s.r.o., Praha.

Ruel MT. 2003. Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. Food and Nutrition Bulletin **24**:231–232.

Savarino G, Corsello A, Corsello G. 2021. Macronutrient balance and micronutrient amounts through growth and development. Italian Journal of Pediatrics **47**:1–14.

Seligman HK, Laraia BA, Kushel MB. 2010. Food insecurity is associated with chronic disease among low-income nhanes participants. Journal of Nutrition **140**:304–310.

Sheehy T, Sharma S. 2013. Trends in energy and nutrient supply in Trinidad and Tobago from 1961 to 2007 using FAO food balance sheets. Public Health Nutrition **16**:1693–1702.

Shogo I, Qiu L, Feng Q, Dupre ME, Gu D. 2021. Healthy Diet. Encyclopedia of Gerontology and Population Aging:1–8.

Swaminathan S, Singh M. 2022. Trace elements, toxic metals, and metalloids in kidney disease. Pages 467–488 Nutritional Management of Renal Disease Nutritional Management of Renal Disease (Fourth Edition).

Tadesse L, Shawel D, Kidanu Y, Yifter H, Mulugeta A. 2005. Vitamin A Deficiency For the Ethiopian Health Center Team.

Tesfaye Abebe. 2005. Diversity in Homegarden Agroforestry Systems of Southern Ethiopia. Tropical resource Management.

The World Bank. 2023. The World Bank in Ethiopia. Available from https://www.worldbank.org/en/country/ethiopia/overview. (accessed March 2024).

Torrens K. 2023. What is a balanced diet for women? Available from https://www.bbcgoodfood.com/howto/guide/balanced-diet-women. (accessed March 2024).

Trumbo PR. 2021. Vitamin B-6 Metabolism in Pregnancy, Lactation, and Infancy. CRC Press, Boca Racon.

Tůmová B. 2014. Fosfor ve výživě člověka. Masarykova univerzita. Available from https://is.muni.cz/th/ziuxb/Tumova_bakalarska_prace.pdf. (accessed March 2024).

Underwood BA, Galal O. 2011. Human Nutrition: An Overview. The Role of Food, Agriculture, Forestry and Fisheries in Human Nutrition - Volume IV **4**:121.

UNDP. 2019. Human Development Reports. Available from https://hdr.undp.org/en/countries/profiles/ETH. (accessed March 2024).

UNDP. 2020. Human Development Report 2020: The Next Frontier Human Development and the Anthropocene. UNDP: New York, NY, USA **2**:1–7.

UNDP. 2022. Ethiopia 2030: A Country transformed? Options for A Next Generation of Reforms. Working Paper Series **8**:1–41.

UNFPA. 2023. World Population Dashboard Ethiopia. Available from https://www.unfpa.org/data/world-population/ET. (accessed March 2024).

UNICEF. 2023. Girls' education. Available from https://www.unicef.org/education/girls-education. (accessed March 2024).

United Nations. 2017. Household size and composition around the world. Data Booklet **2**:4.

US Department of Agriculture. 2019. Definitions of Food Security. Available from https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/definitions-of-food-security/. (accessed March 2024).

USAID, SPRING. 2015. Nutrition of Adolescent Girls and Women of Reproductive Age in Low- and Middle-Income Countries: Current Context and Scientific Basis for Moving Forward. JSI Research & Training Institute **5**:61.

USDA. 2010. Selenium. Available from https://pressbooks.oer.hawaii.edu/humannutrition/chapter/selenium/. (accessed March 2024).

USDA. 2021. Percent of consumer expenditures spent on food, alcoholic beverages, and tobacco that were consumed at home, by selected countries. Available from https://www.ers.usda.gov/media/1r4nwtsu/data-on-expenditures-on-food-and-alcoholic-beverages-in-selected-countries.xlsx. (accessed March 2024).

Wageningen University and Research. 2023. FFQ-tool. Available from https://www.wur.nl/en/show/ffq-tool.htm. (accessed March 2024).

Walther B, Schmid A, Sieber R, Wehrmüller K. 2008. Cheese in nutrition and health. Dairy Science & Technology **88**:389–405.

Wanless E, Judge LW. 2010. Eat to Win: Proper Nutrition for Elite Strength/Power Sport Performance. Indiana AHPERD Journal **39**:23–29.

Warsewicz HG, Rejman K, Laskowski W, Czeczotko M. 2019. Milk and Dairy Products and Their Nutritional Contribution to the Average Polish Diet. Nutrients **11(8)**.

Weil K, Coulibaly I, Fuelbert H, Herrmann A, Millogo RM, Danquah I. 2023. Dietary patterns and their socioeconomic factors of adherence among adults in urban Burkina Faso: a cross-sectional study. Journal of Health, Population and Nutrition **42**:1–21.

West D. 2006. Nutrition, Food, and Fitness, 3rd edition.

WFP. 2024. Ethiopia. Available from https://www.wfp.org/emergencies/ethiopia-emergency. (accessed March 2024).

WHO. 2018. Malnutrition. Available from https://www.who.int/news-room/fact-sheets/detail/malnutrition. (accessed March 2024).

WHO. 2021. Cardiovascular diseases (CVDs). Available from https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds). (accessed March 2024).

Workicho A, Belachew T, Feyissa GT, Wondafrash B, Lachat C, Verstraeten R, Kolsteren P. 2016. Household dietary diversity and Animal Source Food consumption in Ethiopia: Evidence from the 2011 Welfare Monitoring Survey. BMC Public Health **16**:1–11.

World Heart Federation. 2023. DEATHS FROM CARDIOVASCULAR DISEASE SURGED 60% GLOBALLY OVER THE LAST 30 YEARS: REPORT. Available from https://world-heart-federation.org/news/deaths-from-cardiovascular-disease-surged-60-globally-over-the-last-30-years-report/. (accessed March 2024).

Appendices

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Appendix 1: Attached copy of Questionnaire ……II

Appendix 2: Recipes of most consumed meals ……..V

Appendix 1: Attached copy of Questionnaire

Women's dietary diversity questionnaire

The purpose of this questionnaire is to explore food intake and various factors related to this topic. This study is being conducted by Czech Development Agency as part of a project called "Arba Minch Fruit Value Chain, Gamo zone, SNNPR, Ethiopia". This questionnaire asks for your personal information mainly focusing on your household conditions in the first part of the questionnaire and your daily food intake in the second part of the questionnaire. Once the results are published, your answers will be anonymous and will never be linked to your person. Your participation is completely voluntary. Thank you for your cooperation.

Location:_____ Date:_____

Name of respondent:_____ Age of respondent:_____

Level of education:_____ Household size:_____ Religion:_____

What type of house you observe or the respondent has: □ wood with iron roof (Korkoro beit) □ Cement with iron roof (bloket)

□ wooden house with grass roof (gojo beit)

What assets do you observe in the salon of the respondent: □ Fridge □ Sofa □ Television □ None

Sex of household head	☐ Male ☐ Female
Marital status	☐ Married ☐ Single ☐ Divorced ☐ Widowed
Household structure	☐ Member 1:_____ years old ; ☐ Male ☐ Female ☐ Member 2:_____ years old ; ☐ Male ☐ Female ☐ Member 3:_____ years old ; ☐ Male ☐ Female ☐ Member 4:_____ years old ; ☐ Male ☐ Female ☐ Member 5:_____ years old ; ☐ Male ☐ Female ☐ Member 6:_____ years old ; ☐ Male ☐ Female ☐ Member 7:_____ years old ; ☐ Male ☐ Female ☐ Member 8:_____ years old ; ☐ Male ☐ Female ☐ Member 9:_____ years old ; ☐ Male ☐ Female ☐ Member 10:_____ years old ; ☐ Male ☐ Female
Select sources of income (multiple choice)	☐ Selling crops and crop products ☐ Selling livestock or animal products ☐ Money from your relatives and friends ☐ Wage or salary for work ☐ Running your own small business ☐ Government (pension) ☐ Project ☐ Other, specify:
Do you currently have credit/okup?	☐ Yes ☐ No

Tick the months you receive cash income in a year (Multiple answer. Please tick in the box)	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug

Where do you usually get the food? (multiple choice)	☐ Market ☐ Own production ☐ Restaurant ☐ Neighbours ☐ Others

Figure 6 Attached copy of the questionnaire in the English

What is average expenditure on food per month?	.....Birr (ETB)
Which livestock do you have? Please tick and write the number.	☐ Oxe (farming); number= ☐ Cow+calf; number= ☐ Donkey; number= ☐ Goat; number= ☐ Sheep; number= ☐ Hen; number= ☐ Others; number= ☐ None
Which livestock serves as a source of your income?	
Which crops do you plant in your homegarden? Please name them (fruit, vegetable, grains, herbs, spices...)	
Which crops serves as main source of your income?	
Which season do you face shortage of food and why? (multiple choice)	☐ September – November why: _____ ☐ December – February why: _____ ☐ March-May why: _____ ☐ June-August why: _____
Where do you hear about new food consumption practice? (multiple choice)	☐ Extension officer ☐ Family and friends ☐ From health station ☐ Media ☐ Neighbours ☐ Project ☐ Other

Figure 6 Attached copy of the questionnaire in the English (2nd page)

Please write down all the foods (meals and snacks) that you ate or drank yesterday during the day and night, (whether at home or outside the home), and describe the amount of individual food items consumed. Use the table below to determine the amount. When composite dishes are mentioned, please describe also the list of ingred

1) Measurable food items (cereals – teff, corn; legumes, nuts and seeds; spices, condiments, beverages; sweets; oils and fats) A. Tea spoon B. Table spoon C. Ladle D. Handful E. Two handfuls F. Half of the pot (1.5 L) G. Full pot (3 L)		**2) Fruits, vegetables, roots and tubers** (sweet potatoes, potatoes, taro, yam, onion, papaya, mango) A. Number of slices B. Number of pieces C. Juice (100% fruit juice made from fruits or vegetables): small glass (200 mL) big glass (500 mL)	**3) Fosese, Kurkufa** A. ¼ plate B. ½ plate C. Half plate D. ¾ plate E. Number of whole plates	**4) Leaves** (moringa) A. Number of handfuls B. Number of ladles **5) Injera** A. ¼ of injera B. ½ of injera C. Half of injera D. ¾ of injera E. Number of whole injeras
6) Bread (bread, Kita, Kocho) A. Number of slices B. Number of pieces	**7) Eggs** A. Number of eggs	**8) Milk and yoghurt** A. Table spoon B. Small glass (200 ml) C. Bigg glass (500 ml)	**9) Meat** (goat, chicken, fish) A. Number of handful B. Number of ladles	**10) Drink** A. Coffee drink size B. Small glass (200 mL) C. Big glass (500 mL)

Women's dietary diversity questionnaire and nutritional adequacy

	Name of food items	Amount	Did you eat enough quantity of food? (if not, please answer in the next column)	What was the main reason of insufficient feeding?
Breakfast			○ Yes ○ No	○ Not enough food in household ○ Not enough money to buy food ○ Not time to eat during the day because of work pressure ○ Share of food in favour of men and children ○ Others:
Snack			○ Yes ○ No	○ Not enough food in household ○ Not enough money to buy food ○ Not time to eat during the day because of work pressure ○ Share of food in favour of men and children ○ Others:
Lunch			○ Yes ○ No	○ Not enough food in household ○ Not enough money to buy food ○ Not time to eat during the day because of work pressure ○ Share of food in favour of men and children ○ Others:
Snack			○ Yes ○ No	○ Not enough food in household ○ Not enough money to buy food ○ Not time to eat during the day because of work pressure ○ Share of food in favour of men and children ○ Others:
Dinner			○ Yes ○ No	○ Not enough food in household ○ Not enough money to buy food ○ Not time to eat during the day because of work pressure ○ Share of food in favour of men and children ○ Others:

Figure 6 Attached copy of the questionnaire in the English (3rd page)

Appendix 2: Recipes of most consumed meals

Kurkufa

Ingredients: maize flour, water (for small balls), moringa, oil, salt, onion, potato

To make kurkufa, start by boiling water and adding moringa leaves, allowing them to boil briefly before draining the water. In the same pot, introduce oil, diced onions, and a pinch of salt, cooking until the onions are translucent. Incorporate diced potatoes and continue cooking until they are tender. For the maize balls, gradually mix maize flour with water until a dough-like consistency is achieved. Form small balls from the dough, as seen in Figure 7. Drop these maize balls into the simmering mixture, ensuring they are evenly distributed. Allow them to cook through. Finally, mix everything together, ensuring the flavours meld, resulting in a delicious dish with the nutritional benefits of moringa.

Figure 7 Preparation of small maize balls (Author 2023)

Fossese

Ingredients: cornflour**,** kale, red kidney beans**,** chopped green, chopped onion**,** chopped garlic**,** salt, oil

To prepare fossese, begin by gradually mixing cornflour with water to form tiny balls. Heat water with red kidney beans, boiling briefly, then sieve out the water. In a new

batch of water, continue cooking the kidney beans. Once they are almost soft, add chopped kale and cook for three minutes. Arrange the cornflour balls around the pot's edge, starting with the largest, leaving the kale visible in the middle. After 1-2 minutes, repeat with medium-sized balls. Add chopped garlic, green pepper, onion, vegetable oil, and salt to the middle, placing the finest cornflour balls on top. Seal the pot tightly and wait for 3 minutes. The layers are now stratified: kidney beans at the bottom, kale in the middle, and cornflour on top. Transfer to a larger pot, reverse the layers, and mix to evenly distribute everything. Final mixture of the meal is seen in Figure 8.

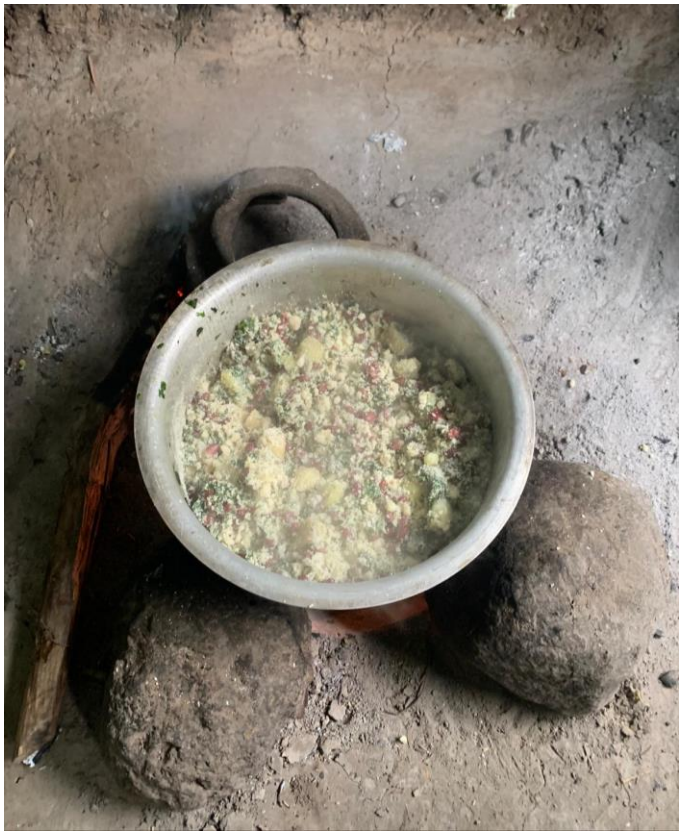

Figure 8 Final look of fossese mixture (Author 2023)

Kitcha (bread)

Ingredients: flour, water, salt

To make kitcha, a traditional Ethiopian flatbread, begin by adding wheat flour and salt to mix it. Combine them and gradually add water until the mixture forms an elastic and smooth dough. Remove the dough and divide it into four equal pieces. Roll each piece into thin flat circles. Heat a suitable pan. Place the flat dough pieces on the heated surface, making small holes across the surface using a fork or fingers. Cook each piece until both

sides turn crispy with a golden-brown color, showcasing the distinctive brown spots characteristic of a traditional kitcha. Kitcha is commonly served with stews, sauces, or as a snack. The preparation of kitcha may vary across regions, and it is a versatile component of Ethiopian meals.

Moringa

Ingredients: moringa, salt, water

To prepare moringa leaves, a nutritious dish often enjoyed in Ethiopia, start by cooking fresh moringa leaves in water (as shown in Figure 9). Simply add the desired amount of moringa leaves to a pot of water and bring it to a gentle boil. Once the leaves are tender, add salt to taste, enhancing the flavour. Moringa is highly valued in Ethiopia for its nutritional benefits, rich in vitamins, minerals, and antioxidants. It is a staple in many Ethiopian dishes, contributing not only to the taste but also providing a healthy boost.

Figure 9 Preparation of moringa for cooking (Author 2023)

Finally, the Figure 10 shows all the dishes on one plate, with this size of dish usually representing two portions for one person. On the left side is the kitcha, in the middle of the plate is the fossese mixture. The corn ball combined with moringa at the bottom of the plate is kurkufa and the green portion on the right side is cooked moringa leaves.

Figure 10 Mixture of traditional meals (Author 2023)