

# Nutrition transition in Kyrgyzstan: Understanding the triple burden of malnutrition and the importance of dietary quality

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## List of abbreviations

|          |   |
|----------|---|
| BMI:     | body mass index                             |
| DD:      | dietary diversity                           |
| DDS:     | dietary diversity score                     |
| DGLV:    | dark green leavy vegetables                 |
| DRI:     | daily recommended intake                    |
| FAO:     | Food and Agriculture Organisation           |
| LMICs:   | lower- and middle-income countries          |
| MAR:     | mean nutrient adequacy ratio                |
| NAR:     | nutrient adequacy ration                    |
| NCDs:    | non-communicable diseases                   |
| NR-NCDs: | nutrition-related non-communicable diseases |
| RDA:     | recommended daily allowance                 |
| SSB:     | sugar-sweetened beverage                    |
| WDDS:    | women's dietary diversity score             |
| WHO:     | World Health Organisation                   |
| WRA:     | women of reproductive age                   |
| WWII:    | Second World War                            |



## Preface

In 2014 in the framework of my Master thesis, I conducted a research study on child malnutrition in Southern Kyrgyzstan. Back then, I realized that maternal socio-economic background and nutritional knowledge play a crucial role in the well-being, health, and diet of children. After the successful defence, I continued studying this under-researched theme in Kyrgyzstan. For this doctoral dissertation, analysis of a broader historical, political, economic, and cultural context (macro-level) of nutrition transition and studying food consumption patterns of women of reproductive age (micro-level) have given a better understanding of the current nutritional situation and challenges. It resulted in two published articles in peer-reviewed journals (*Sustainability*, IF 3.251 and *Nutrients*, IF 5.719) that are indicated below and are comprised in the dissertation:

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## Abstract

Nutrition transition, including changes in lifestyle and diet, has been taking place globally. Malnutrition is a serious public health issue responsible for the considerable portion of non-communicable diseases (NCDs). Currently, little knowledge about nutrition transition and its relation to malnutrition exists in low and middle-income countries. Kyrgyzstan undergoes a nutrition transition with health and diet implications, especially to women. Kyrgyzstan is believed to be at the end of the 'receding famine' stage and the beginning of the stage of 'degenerative diseases' according to the theory of nutrition transition. Despite recent improvements in some nutritional indicators, micronutrient deficiency is still common. This dissertation aims (1) to make an overview and analyse nutrition transition in Kyrgyzstan over the past 170 years by highlighting changes in diet and lifestyle together with the rudimentary shifts associated with it; (2) explore determining factors of dietary quality of women of reproductive age (WRA) and (3) understand possible exposure to the Western diet and its implications. Employing convergent mixed methods design, this work goes through two phases. First, Popkin's theoretical framework on nutrition transition guides to identify shifts, patterns and trends on a macro level. Analysis was based on thematic networks extracted from the theory and literature. Second, a cross-sectional study involving 423 WRA was performed on a micro-level. Information on food consumption was obtained from the 24 h dietary recall. Using Nutrisurvey software, 16 nutrients were calculated. These are namely energy, protein, carbohydrates, fibre, fat, vitamins A, C, E, B1, B2, B6, zinc, iron, folate, magnesium, and calcium. Additionally, questions for assessing dietary diversity based on the FAO's food groups were included in the survey. Nutritional status, dietary diversity score (DDS), nutrient adequacy ratio (NAR) and mean adequacy ratio (MAR) were calculated. Correlations between DDS, NAR, MAR for 16 macro- and micronutrients were measured with socio-economic, demographic, farm variables. Mean DDS among WRA in low-income context was 4.71, which is lower than the threshold of 5. The average DDS among rural women was higher than among women in cities. Low dietary diversity indicates micronutrient deficiency among this group of surveyed women. Further analysis reveals that shortage of zinc, iron, folic acid, magnesium, calcium, vitamin B1, B2, B3, C and E. availability of a homestead garden positively correlated with dietary quality. Kyrgyzstan has undergone major socio-economic, political, demographic, and lifestyle changes for the last 170 years. The modern Kyrgyz population's food regime was influenced by the profound transformations of the socio-economic structure, altering food culture and especially the transition of former nomads to the sedentary lifestyle. The shift from the subsistence and planned economy to a market economy and trade liberalization led to the preference for readily available and easily made highly processed food. Higher intake of processed food, fats, sweets, and animal products impacted the nutritional status. It has increased obesity levels among the adult population while leaving vulnerable parts of the population micronutrient deficient. Micronutrient deficiency is a serious health issue among WRA in the low-income context in Kyrgyzstan. The dissertation also explored forgotten and neglected plants, foods and drinks which are nutrient-dense and mostly grow freely in nature and are part of traditional cuisine. The locally available foods should be included in the government nutritional programs to fight current malnutrition's triple burden. This work can serve as a guide for developing a dietary recommendation for WRA in Kyrgyzstan.

## Zusammenfassung

Der Wandel in der Ernährung, der auch Veränderungen in der Lebensweise und der Diät umfasst, findet weltweit statt. Mangelernährung ist ein ernstes Problem der öffentlichen Gesundheit, das für einen großen Teil der nicht übertragbaren Krankheiten verantwortlich ist. In Ländern mit niedrigem und mittlerem Einkommen gibt es derzeit nur wenig Wissen über die Ernährungsumstellung und ihren Zusammenhang mit der Mangelernährung. Kirgisistan befindet sich in einer Ernährungsumstellung, die sich auf die Gesundheit und die Diät insbesondere von Frauen auswirkt. Nach der Theorie des Ernährungswandels befindet sich Kirgisistan am Ende des Stadiums des "zurückgehenden Hungers" und am Beginn des Stadiums der "degenerativen Krankheiten". Trotz der jüngsten Verbesserungen bei einigen Ernährungsindikatoren ist Mikronährstoffmangel immer noch weit verbreitet. Ziel dieser Dissertation ist es, (1) einen Überblick über die Ernährungsumstellung in Kirgisistan in den letzten 170 Jahren zu geben und diese zu analysieren, indem Veränderungen in der Ernährung und im Lebensstil sowie die damit verbundenen rudimentären Veränderungen aufgezeigt werden; (2) die Faktoren zu erforschen, die für die Qualität der Ernährung von Frauen im reproduktiven Alter (WRA) ausschlaggebend sind, und (3) die mögliche Exposition gegenüber der westlichen Ernährung und deren Auswirkungen zu verstehen. Unter Verwendung eines konvergenten Mixed-Methods-Designs durchläuft diese Arbeit zwei Phasen. Zunächst wird der theoretische Rahmen von Popkin zum Übergang in der Ernährung herangezogen, um Verschiebungen, Muster und Trends auf Makroebene zu ermitteln. Die Analyse basierte auf thematischen Netzwerken, die aus der Theorie und der Literatur abgeleitet wurden. Zweitens wurde eine Querschnittsstudie mit 423 WRA auf der Mikroebene durchgeführt. Die Informationen zum Lebensmittelkonsum wurden aus der 24-Stunden-Erinnerung an die Ernährung gewonnen. Mithilfe der Nutrisurvey-Software wurden 16 Nährstoffe berechnet. Dabei handelt es sich um Energie, Eiweiß, Kohlenhydrate, Ballaststoffe, Fett, die Vitamine A, C, E, B1, B2, B6, Zink, Eisen, Folsäure, Magnesium und Kalzium. Zusätzlich wurden Fragen zur Bewertung der Ernährungsvielfalt auf der Grundlage der FAO-Lebensmittelgruppen in die Erhebung aufgenommen. Berechnet wurden der Ernährungszustand, der Ernährungsdiversitäts-Score (DDS), der Nährstoffadäquanzquotient (NAR) und der mittlere Adäquanzquotient (MAR). Korrelationen zwischen DDS, NAR und MAR für 16 Makro- und Mikronährstoffe wurden mit sozioökonomischen, demografischen und Lebensmitterversorgungs Variablen gemessen. Der durchschnittliche DDS-Wert von Frauen aus einkommensschwachen Familien lag bei 4,71 und damit unter dem Grenzwert von 5. Der durchschnittliche DDS war bei Frauen auf dem Land höher als bei Frauen in der Stadt. Die geringe Vielfalt in der Ernährung deutet auf einen Mikronährstoffmangel in dieser Gruppe der befragten Frauen hin. Eine weitere Analyse zeigt, dass ein Mangel an Zink, Eisen, Folsäure, Magnesium, Kalzium, Vitamin B1, B2, B3, C und E besteht und dass das Vorhandensein eines Hausgartens positiv mit der Qualität der Ernährung korreliert. Kirgisistan hat in den letzten 170 Jahren große sozioökonomische, politische, demografische und lebensstilbezogene Veränderungen durchlaufen. Das Ernährungsverhalten der modernen kirgisischen Bevölkerung wurde durch den tiefgreifenden Wandel der sozioökonomischen Struktur, die Veränderung der Ernährungskultur und insbesondere den Übergang der ehemaligen Nomaden zur sesshaften Lebensweise beeinflusst. Der Übergang von der Subsistenzwirtschaft zur Marktwirtschaft und die Liberalisierung des Handels führten zur Bevorzugung leicht verfügbarer und einfach hergestellter, stark verarbeiteter Lebensmittel. Der höhere Verzehr von verarbeiteten Lebensmitteln, Fetten, Süßigkeiten und tierischen Produkten wirkte sich auf den Ernährungszustand aus. Dies hat zu einem Anstieg der Fettleibigkeit unter der erwachsenen Bevölkerung geführt und gleichzeitig einen Mikronährstoffmangel in gefährdeten Bevölkerungsgruppen hinterlassen. Mikronährstoffmangel ist ein ernsthaftes Gesundheitsproblem bei Frauen in einkommensschwachen Verhältnissen in Kirgisistan. In der Dissertation wurden auch vergessene und vernachlässigte Pflanzen, Lebensmittel und Getränke untersucht, die eine hohe Nährstoffdichte aufweisen, meist frei in der Natur wachsen und Teil der traditionellen Küche sind. Die lokal verfügbaren Lebensmittel sollten in die staatlichen Ernährungsprogramme aufgenommen

werden, um die derzeitige Dreifachbelastung durch Mangelernährung zu bekämpfen. Diese Arbeit kann als Leitfaden für die Entwicklung von Ernährungsempfehlungen für WRA in Kirgisistan dienen.

# Chapter 1. General introduction

## 1. Introduction

Malnutrition is the main culprit of poor health globally [1]. Unhealthy diets are one of the major contributors to non-communicable diseases (NCDs), especially in low-and middle-income countries (LMICs) [2]. The contemporary world faces challenges due to increased obesity and rising nutrition-related NCDs rates [3]. The promotion of healthy diets would prevent and tackle the consequences of malnutrition.

Healthy diets are a vital objective that impacts several sectors. Due to the rising attention to the topic of healthy diets from the side of governments, civil society, the international community, academic sector and business, FAO and WHO have developed a definition and its underlying principles [4]. These refer to 1. Human health and well-being; 2. Environmental sustainability; 3. Affordable, safe, equitable and accessible; 4. In accordance with a food culture [4]. While the principles are comprehensive and entail various levels and dimensions of nutrition, recent attention has been paid to diets with relatively lower energy density and high nutrient-dense foods [5]. This emphasis is drawn by the frequent consumption of fast foods and soft drinks and their association with overweight and obesity [6].

Healthy diets are based on plant-based foods, including fruits and vegetables, whole grains and legumes, which positively impact human health. Reduction in consumption of semi-manufactured foods and highly processed foods is associated with human and animal health well-being as well as environment [7].

The COVID-19 pandemic has inevitably impacted the world food security [8]. The number of people affected by the instabilities of the food system increased in 2020 [8]. It has showed pitfalls of our food system by inevitably affecting it. Recent findings from Latin America and the Caribbean state that the prevalence of hunger and households having moderate or severe food insecurity increased in 2020 [9]. Other regions may likely to show the same result.

Regardless of the pandemic, dramatic dietary changes have been going on during the last decades [2]. Improving diets is a challenging process as it requires reconsideration of the entire food system, which includes numerous stakeholders in the entire food production and consumption cycle [4]. Nutrition programmes should focus on preventing unhealthy dietary intake additionally to ensuring micronutrient deficiency and food security [2].

Projections for future claim that SDG2 zero hunger is hard to achieve by 2030 in business as usual scenario [10]. Therefore, it is crucial that governments, international community and business sector reconsider their approach in fighting all forms of hunger. This work contributes directly or indirectly to the following Sustainable Development Goals (SDGs). UN has set forth that by 2030 the world will 'end hunger, achieve food security and improved nutrition and promote sustainable

agriculture' in the framework of SDG 2. Specific targets of SDG 2 include insurance of 'universal access to safe and nutritious food' (Target 2.1), 'end all forms of malnutrition' (Target 2.2), 'double the productivity and incomes of small-scale food producers' (Target 2.3), ensure 'sustainable food production and resilient agricultural practices' (Target 2.4). SDG3 states that we need to 'ensure healthy lives and promote well-being for all at all ages'. Specifically, it aims to 'reduce maternal mortality' (Target 3.1), reduce mortality from non-communicable diseases and promote mental health (Target 3.4) [11].

### 1.1. Background of the topic

A food system is a broad concept in which activities, infrastructure, and people engage to feed the population [3]. It is a dynamic system that is responsive to different stakeholders, including policymakers and participants of a value chain [12]. The current food systems have their drawbacks due to the lack of capacity to ensure health, prevent social disparity and ensure sustainable production [13]. According to the E.A.T Lancet report [14], these systems threaten health and environmental sustainability. They also contribute to 20-35% of global greenhouse gas emissions and are responsible for deforestation, biodiversity loss and land degradation [4].

Current food systems entail inequality and imbalance, by giving privileges to some actors to profit from it while others are in disadvantaged positions [4]. Strategies to feed the rising global population have been concentrated on increasing agricultural productivity [15]. With the rising food production, diets have become energy-dense but nutrient-poor. Constant consumption of such food often lead to micronutrient deficiencies in human organisms [15].

Contemporary food system transformation suggests that preference for ultra-processed foods and beverages is on rise in all regions of the world. However, this process is rapid in lower and middle-income countries [16]. Animal-based diet has an enormous environmental impact. A study shows that reduction in consumption of foods originating in animals reduced burden on environment. These foods include beef, milk products, fish, and honey, which also have a negative impact on animal welfare [7]. Increased consumption of energy-dense and animal-based foods coupled with less plant-based products contributes to the development of cardiovascular diseases and diabetes [7] exacerbating the environment.

Regardless of the fact that current food production is at its maximum level, millions of people suffer from hidden hunger. Marginalized parts of society have a higher propensity of experiencing it [15][17]. Hidden hunger occurs when several important micronutrients are lacking in the human organism. These usually result from having an energy-dense but a nutrient-poor diet. Due to poverty, persons in disadvantaged areas in low- and middle-income countries consume monotonous food consisting of low-cost staples and have limited food choices [15].

It is essential to strengthen the resistance of the current food system to external shocks such as economic crises and situations resulting from environmental catastrophes and armed conflicts [8]. Furthermore, food system transformation should include affordability of healthy diet for low- and middle-income households [18].

Few global nutrition initiatives highlight the importance of traditional knowledge, cooking methods, indigenous plants and herbs to improve nutrition [5]. Global initiatives should emphasize individual food choice and its impact on the environment, health and nutrition [5]. They should also specifically target healthy diets on a global level [14]. It is vital to develop long-term strategies to improve the food system's resistance to global shocks [15] by seeking ways to make it sustainable.

## 1.2. Statement of the problem

Malnutrition refers primarily to undernutrition, overnutrition and micronutrient deficiency [19]. While undernutrition and overnutrition can be visible physically, a lack of micronutrients might not be obvious. Globally around 40% of pregnant women suffer from anaemia which is mainly caused by nutritional deficiencies, mostly iron deficiency, lack of folate, vitamins A and B12 in the organism of women [20]. Women of reproductive age (WRA) and pregnant women are susceptible to anaemia [21]. Anemia levels among WRA in Kyrgyzstan was 35.8% in 2019 [22].

Although undernutrition rates have decreased in Kyrgyzstan for the last 30 years, micronutrient deficiency remains a public concern. Daily diet provides humans with the most necessary micronutrients. Therefore, the consumption of diversified foods is important for human health and thus the proper intake of micronutrients [23][24]. Maternal nutrition is important for its future offspring. It is vital to have a proper diet throughout the reproductive years [25]. Overweight or obesity with micronutrient inadequacy can exist concomitantly [26]. Recent findings show that overweight and obesity can exist with micronutrient deficiencies [24].

WRA are especially vulnerable to a lack of micronutrients vital for the human organism [24]. Existing literature confirms that underprivileged women are at higher risk of suffering from a lack of micronutrients in Vietnam [27], Mumbai [28], Sri Lanka [17], Burkina Faso [29] and other countries. Shortage of iron, zinc, calcium, iodine, vitamin A, B1, B2, B6, B12, D, folate, selenium in WRA is mentioned in the literature [30][31][25]. Moreover, during economic shocks, female-headed households tend to consume less protein and iron than male-headed families. Therefore, the empowerment of women in nutrition programmes is vital [32].

Figure 1 shows various levels of determinants impacting the triple burden of malnutrition: undernutrition, overnutrition and micronutrient deficiency. Fundamental, underlying, intermediate causes exist which directly or indirectly might lead to the triple burden of malnutrition. This dissertation takes a macro and micro approaches to understanding micronutrient deficiency through societal



transformations and individual food consumption. It is important to understand socio-economic status, income, residence location [33] when studying nutrition and health.

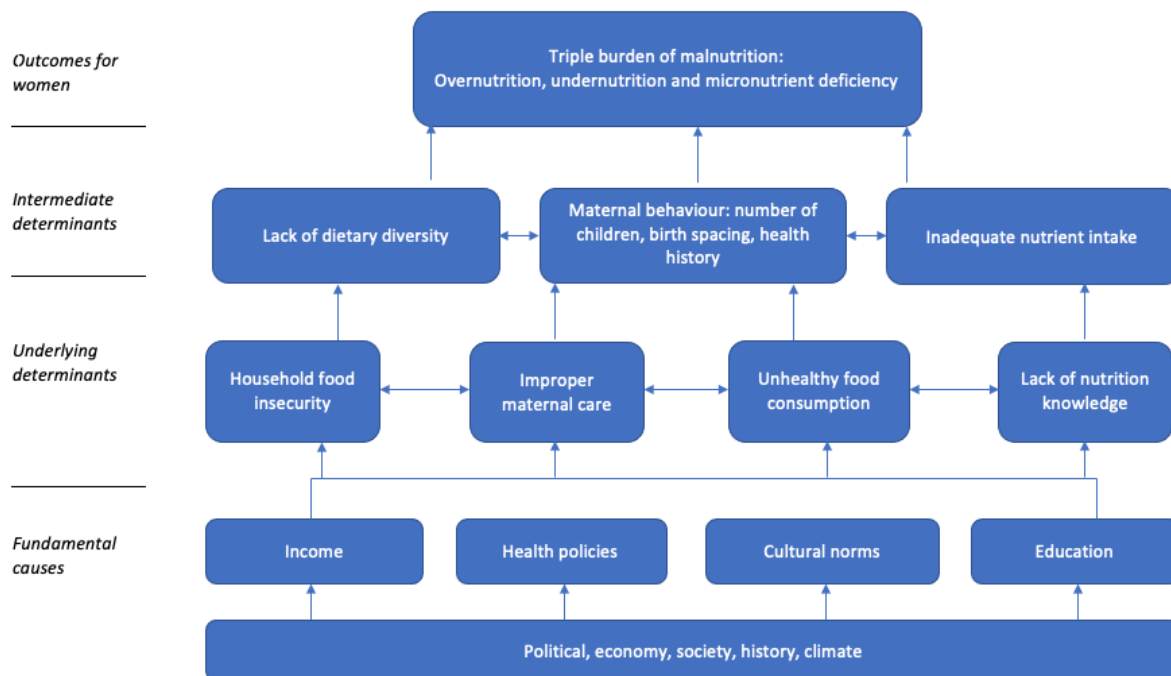


Figure 1. Conceptual framework on the determinants of triple burden of malnutrition (adapted from [34] [35])

Malnutrition has multiple causes, including those which impact directly as well as indirectly. For example, infections, poor hygiene and sanitation, lack of access to health care can be one of the causes of malnutrition [36].

### 1.3. Structure of the thesis

The structure of the thesis is comprised in the following way:

*Chapter 1* presents the background of the study, literature on nutrition in the world and in Kyrgyzstan, short historical overview of socio-economic development and its possible impact on food culture. Additionally, the importance of this work, research questions and hypothesis are discussed here.

*Chapter 2* includes the first original research study that discussed and analysed the transformation of food culture among Kyrgyz nomads for the last 170 years.

*Chapter 3* presents the second original cross-sectional study on understanding the dietary quality of WRA in Kyrgyzstan.

*Chapter 4* presents the key findings and the general discussion of the topic together with findings of other relevant studies. It highlights similar research works and draws a connection with the results. Also, the strengths and limitations of the thesis coupled with policy recommendations are in this section.

*Chapter 5* concludes with this work's contribution.

*Chapter 6* presents the full bibliography of the dissertation.

*Chapter 7* includes appendices.

## 2. Literature review

### 2.1. Theoretical framework: Popkin's theory of nutrition transition

As societies undergo various transition stages, food has always played a fundamental role in certain periods. For instance, historically, famines killed parts of the population. The lack of food weakened human organisms thus making them susceptible to infectious diseases. Today, junk food leads to obesity and a lack of micronutrients [37].

According to Popkin's nutrition transition theory, five stages exist explaining social transformation in light of changes related to food and nutrition (Figure 2). The nutrition transition is closely related to the epidemiological and demographic transition. The former belongs to the shift from infectious diseases to degenerative ones. This happened due to the development of vaccines, hygiene and sanitation, and the eradication of extreme undernutrition. The latter refers to the shift from high fertility and mortality to low fertility and low mortality, which is typical of industrial societies. The first pattern is named mainly 'Collecting food', referring to the hunter-gatherer societies. Their diets were mainly carbohydrates- and fibre-based and low in fat. Due to the constant movement in search of food and shelter, obesity levels were low. The second pattern 'Famine' is characterized by instability in food, chronic hunger, and undernutrition. Due to social stratification, differences in famine levels were varied. The third phase belongs to the period of alleviating hunger, as its name implies, through increased intake of animal-based protein, fruits, and vegetables. More people have leisure time and less physical activity. In pattern 4, household incomes increase, and consumption of total fat, refined carbohydrates, sugar increases, whereas intake of fibre and polyunsaturated fatty acids decreases. These changes are coupled with reduced physical activity leading to obesity and the development of nutrition-related non-communicable diseases. The last phase, called 'behavioural change', occurs when diet and physical activity changes take place to prevent degenerative diseases [38][39][40][41]. However, some authors believe that stage 5 of the nutrition transition has not been achieved even in high-income countries where obesity rates are rising [10].

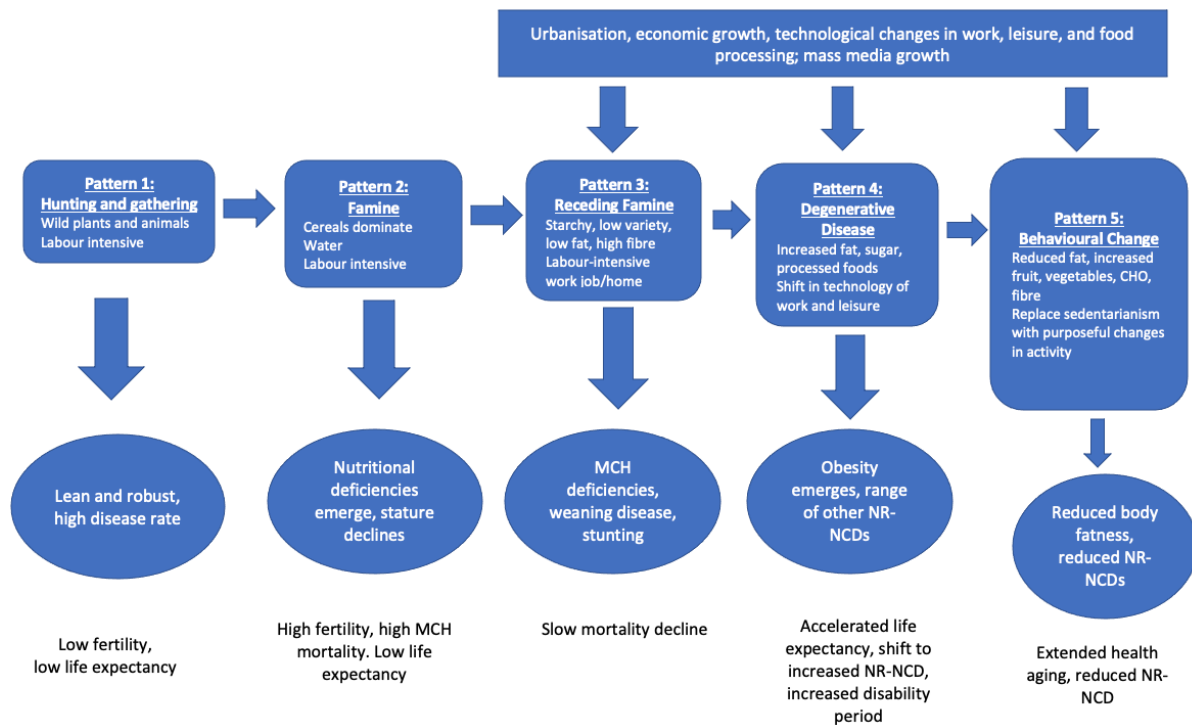


Figure 2. Theory of nutrition transition [38][41]

With the rise of GDP and urbanisation processes, low and middle-income countries also experience nutrition transition [42]. Transformation of food systems has been taking place in developing countries switching from traditional foods to the ones of the Western-type [43]. Shifting towards increased intake of sugars, animal-source protein, trans fats, processed and packaged food products [38][42]. NR-NCDs were believed that mostly affluent people suffer, but the situation has been changing, and more low- and middle-income countries have seen its rise [38]. Reduced physical activity coupled with diet changes explain growing overweight and obesity rates in LMICs. Increased availability and consumption of ultra-processed foods serve as an explanatory cause for this phenomenon[44]. With the rise of household incomes, animal-based protein consumption such as meat, poultry, fish and milk products rises [45].

In the course of my research, I have thought through the meaning of ‘traditional foods’. The concept is often used in the literature with various meanings. I asked myself how I define it in order to omit ambiguity so that the definition would better explain the current food culture in Kyrgyzstan. The concept of traditional food has a complex and dynamic nature and will differ depending on the situation – place and a person’s background [46]. Consulting with the concept in the European context, I use Guerrero and colleagues’ (2009) multi-faceted explanation, inclining that traditional food is simple, basic, natural, clean and with very little or absence processing. It is a habitual part of daily life, widespread in certain locations(s), consumed for festive occasions, homemade, without artificial additives and transmitted from generation to generation. It is a food belonging to a certain location, having a specific taste and smell

known to the locals for its artisan character [47]. Thus, traditional recipes are foods inherited from ancestors, using locally available ingredients and methods, consumed locally and are part of the local cuisine [48].

Nutrition is referred to only diet but also to physical activity and body composition. The rapid growth of the urban population is taking place more intensively in lower and middle-income countries. Another factor influencing is the change of work types by shifting from labour-intensive jobs to and influence of mass media. These societal changes are happening due to globalization, which hinders us from exact measurement. The shift from a subsistence economy to an industrialized one took place within 30-40 years in most parts of the world [49]. Increased income and urbanisation lead to more consumption of foods of animal origin, sugar, refined grains, fats and oils and processed foods [50].

Food consumption has been shifting from freshly locally available fruits and vegetables to processed and packaged manufactured products mostly sold in supermarkets. Obesity occurs when energy intake is higher than the body's needs [37]. The proximity of markets with cheaper and diverse foods lets consumers buy more processed foods. For urban low-income households, the cheap food choices are often unhealthy [50]. Therefore poor people tend to be obese [49]. Access to unhealthy foods is widespread in urban areas [50]. The contemporary urban diet consists of sugars and grains consisting of a high glycemic index, which were not part of the diet 200 years ago [51]. This situation shows that Western diet may likely contribute to the development of chronic diseases [51].

Prevention of NCDs, including cardiovascular diseases, cancer and obesity, require long-term changes in lifestyle. Technological advances and improvements in food production led to the yield increase reducing hunger in the world. However, these shifts undermine healthy diets by increasing consumption of diets high in calories, ultra-processed and foods of animal origin which in its turn leads to obesity [52]. A large portion of the population remains undernourished [49]. Policies and programs for preventing NR-NCDs have not been developed. The causes and consequences of dietary shifts should be better understood, and more emphasis should be on preventive measures [49].

The need for understanding the consequences of the food systems is vital. With the rapid urbanisation processing occurring in most parts of LMICs, it is critical to study food consumption patterns in growing populations residing within and in the outskirts of urban areas [36]. It is fundamental that research concentrates not only on food consumption data but also integrates data on micronutrient status as well [36]. Understanding micronutrient deficiency is important for further analysis the effects of malnutrition and better development of nutrition policies in future.

## 2.2. Actual issues related to nutrition in Kyrgyzstan

Kyrgyzstan is a former Soviet Union state located in Central Asia between Kazakhstan in the north, China in the south-east, Uzbekistan in the west and Tajikistan in the south-west (Figure 3). With a population of roughly 6.6 million people, the country belongs to the smallest state in the region. Gold production (10% of GDP), remittances (25% of GDP) and foreign aid strongly support the economy [53]. Thanks to remittances, the poverty rate declined from 39.9% to 20.1% during 2006-2019 years prior to the pandemic. However, considerable part of the population still lives in poverty. In fighting poverty more attention should be given to the urban poor than the rural [32].

Undernutrition, overnutrition, micronutrient deficiency, and diet-related NCDs are present in Kyrgyz society, worsening the population's health situation. Recent rises in overweight and obesity among children and adults is of particular concern. Income share on food expenses among disadvantaged households is high, constituting over 60% of total expenditures. Almost 50% of the population could not afford proper nutrition in 2019, consuming less than 2100 kcal a day. Given the large share of engagement in the informal economy, the urban poor suffered the most from the economic shocks resulting from the pandemic [32].

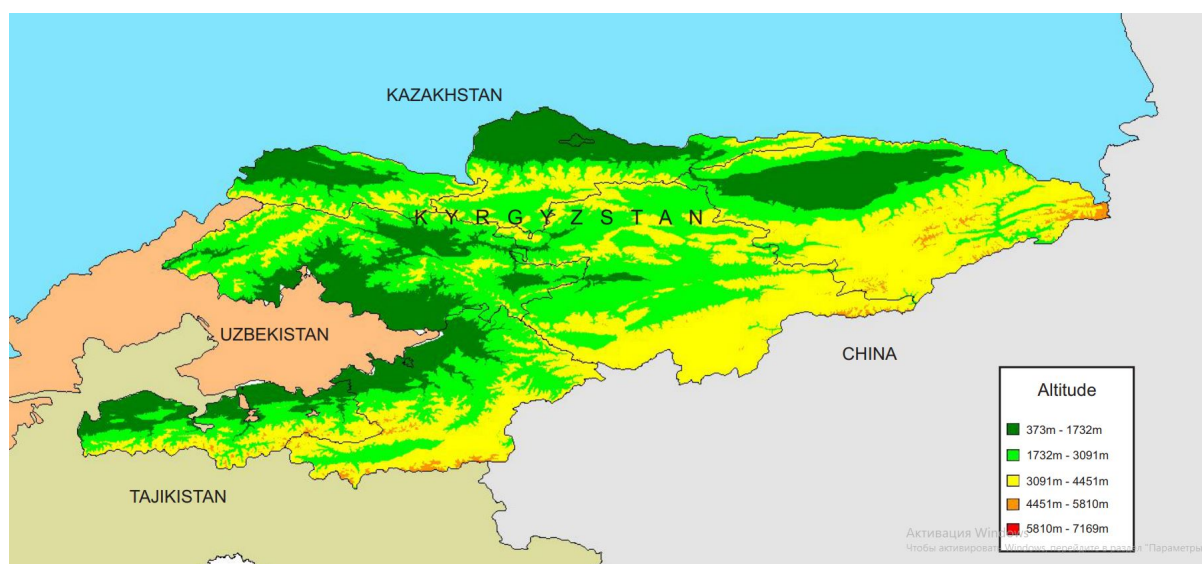


Figure 3. Map of Kyrgyzstan, made with [54]

Similar to the world trend [3], the food system started its transformation after the World War II when the Soviet nutrition policies aimed to increase the energy intake of the population that got devastated from the war. This pattern has remained

after the dissolution of the Soviet Union regardless of the globalisation processes taking place through liberalisation of economies.

In the 1990s the share of undernutrition was high in Kyrgyzstan. However, this picture has been changing as overweight and obesity are becoming a serious public health problem. At the same time, despite supplementation programs and food fortification strategies, micronutrient intake is low. This phenomenon in Kyrgyzstan is similar to a situation with nutrition in some Asian countries [31].

Looking back in food history, food storage was crucial for the survival and well-being of nomadic culture. Through traditional food-processing, animal SFAs [51] could be stored for a longer time, such as *kurut* (hard cheese), ghee (clarified butter), tallow and other sources of energy for future consumption. Food preservation techniques made it possible to consume nutrient-dense foods during harsh winters as well. Practically all animal was from free-range and fed in the pasture. Consumption of wild animals was also part of the diet. With monogenisation of agriculture and monotonous diets especially among low resource communities, nutritional status of women diverted. The next subsection will highlight existing gaps in the literature.

### *Gaps in the literature*

Literature on the nutrition transition generalises LMICs in terms of the westernization of diets. However, nuanced exploration of food consumption on a country or a regional level is necessary to understand with which speed countries are switching to Western diets [44]. Nutrition transition theory has two limitations. Firstly, it relies on national data omitting regional inequalities. Secondly, in developing countries where the share of agricultural production is high, food sources might come from self-production, which is not accounted for in national statistics [37]. To date, there is little knowledge about how nutrition transition is taking place and particularly individual food consumption data is non-existent in Kyrgyzstan. Especially little knowledge exists on diet quality and micronutrient status of WRA.

Considering the above-mentioned existing gaps, this dissertation sets forth the following objectives, research questions, and arguments into account.

### 2.3. Research questions and objectives

Based on the problem statement and literature review, this thesis attempts to explore the following research questions:

- How has nutrition transition been taking place in Kyrgyzstan for the last 170 years?
- What determining factors are crucial for the dietary quality of women between 18 and 49?
- What is the role of traditional foods and ultra-processed foods in the contemporary diet?

- Where does Kyrgyzstan stand in terms of food transition?

The objectives of these questions are to:

- make a historical overview of major changes which have occurred in the past 170 years within Kyrgyz communities. To examine the demographic and nutrition transition in Kyrgyzstan in light of its contribution to the emergence of nutrition-related non-communicable diseases,
- understand how three political and economic systems are related to nutrition transition; to better understand current nutrition transition and its effect on women,
- explore forgotten foods and medicinal plants. Explore traditional nomadic foods and understand the food culture and livelihoods of nomadic tribes,
- understand how diversified the diet of women 18-49 years old in Kyrgyzstan is and their similarities and differences in urban and rural areas,
- explore determining factors impacting dietary quality among women,
- understand whether dietary diversity score (DDS) can be a proxy for micronutrient deficiency in the context of women of reproductive age (WRA) from low-income families of Kyrgyzstan. Assess current dietary status in context of Westernizing diets,
- understand where Kyrgyzstan stands in terms of nutrition transition.

Main hypothesis:

- With the shift to industrialisation of agriculture and marketisation of the economy, centuries-long consumed authentic food is under the danger of disappearance, and the growing popularity of Western-oriented food impacts nutrition transition and health pattern of population.
- triple burden of malnutrition, consisting of undernutrition, overnutrition and micronutrient deficiency, exists in Kyrgyzstan.
- Women of reproductive age are vulnerable to different forms of malnutrition due to socioeconomic and demographic factors. Policies and resources are mostly allocated to fight child malnutrition, and less attention is directed to maternal nutrition.
- Locally available foods can possibly contribute to the fight against malnutrition.
- Increased income and urbanisation lead to more consumption of foods of animal origin, sugar, refined grains, fats and oils and processed foods.
- Women in rural areas have better chances to have good dietary quality than women residing in cities.
- Traditional food is still an essential part of women's diet.

## 2.4. Novelty of the thesis

This dissertation aims to contribute to three levels in society – scientific, policy, and societal levels. On a scientific level, the dissertation's findings will contribute to the literature on dietary diversity among WRA, especially in low-income contexts. To the best of my knowledge, it is the first study 1) analysing nutrition transition in the Kyrgyzstani context; 2) aiming to understand dietary diversity (DD) in Kyrgyzstan. Thus, it will contribute to a better understanding of food and nutrition peculiarities in Central Asia due to its similarities in political, historical, economic, and cultural background.

The government of the Kyrgyz Republic has developed several policies aiming to improve child malnutrition. In the context of child nutrition programs, maternal health and nutrition have been discussed. However, today no governmental approved dietary guidelines for WRA in Kyrgyzstan exist. This dissertation aims to contribute to the development of guidelines for women of different life stages to improve their health and the one of the future generations.

In the context of increased intake of obesogenic foods coupled with increased rates of NR-NCDs globally, understanding dietary transition in Kyrgyzstan has significant societal implications. So far, most developed and LMICs have decreased undernutrition rates among their populations. While this is a positive sign, obesity rates globally have been rising. Exploring nutrition trends in Kyrgyzstan is a crucial step to foresee and prevent this scenario. Population health is the primary factor of a nation's well-being.

## 3. Materials and methods

This doctoral research employed an interdisciplinary approach using basic nutrition and social sciences methods. It seeks to answer a set of different research questions involving quantitative and qualitative methods. Therefore, the usage of the mixed methods approach serves as suitable guidance to explore [55].

Theory application in this dissertation has a vital function. It helps to explain why certain methodologies were chosen and set a study framework that serves as a direction to a researcher [56]. First, based on the nutrition transition framework, I extracted trends and patterns which drive the transformation of nutrition from one stage to another. Indicators on demographic change, economic growth, and rate of change in infectious and non-infectious diseases were analysed to understand whether Kyrgyzstan undergoes fundamental transitions that were important for nutrition. Second, given the political and economic transformations which took place for the last 170 years: 1) tribal system; 2) socialism; 3) liberal economy, I attempted to



understand how Popkin’s four stages of nutrition transition can be interpreted during these three systems.

A convergent mixed methods design [55] was adopted involving two stages (Figure 4). First, guided by the nutrition transition theory, we identified key literature to understand patterns and trends leading to nutrition transition in Kyrgyzstan (macro-level). Analysis of societal changes through the theoretical framework was performed through exploration of qualitative data and quantitative data as supporting. Data from the expert interviews (n=15), together with observations, and relevant literature, were extracted. Quantitative analysis of trends on a country level and nutrition patterns and national statistical data on economic development, demographic growth, food balance sheets, data on diseases, technological growth, and other important statistics was used. Semi-structured literature search and review: for this we did such literature search in history, ethnography, and food. Then we explored grey literature of international organisations such as WHO, FAO, and WFP. Thematic results were integrated and construed according to the theoretical framework. Understanding how nutrition evolved together with the shifts in politics and economy is a challenging and broad task. Thematic analysis and networks [57] were employed as a suitable analytic tool for pursuing this objective. We conducted semi-structured interviews and recorded the responses using written notes. An exploratory expert interview was employed in this study in order to acquire information and orientation on the topic [58].

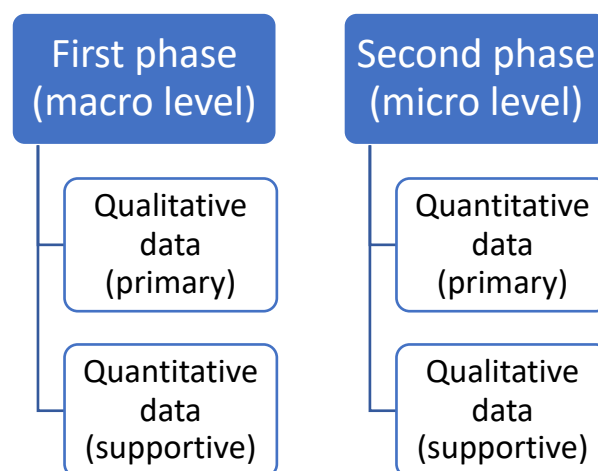


Figure 4. Visual explanation of research design (Author’s illustration)

Second, quantitative data (obtained through a survey) was performed to assess the dietary quality of women of reproductive age. The survey consisted of questions on socio-economic, demographic, agricultural, nutritional parameters. It also had open-ended questions whose answers were used as supporting information.

The thesis has both inductive and deductive reasoning and made analysis of macro (country level) and micro (household) level. The methodologies used in this work are shown in Table 1.

Table 1. Overview of methodologies used in this thesis

| Item  | Type of method and software used                                     | Data and sources  | Chapter |
|---|--|---|---------|
| Analysis of societal changes and nutrition transition         | Qualitative<br>Thematic analysis and networks<br>MAXQDA              | Works of ethnographers and historians<br><br>Interviews with key informants<br>Literature on food policy, dietary diversity, history of nomadic food culture, semi-structured expert interviews | 2       |
| Traditional foods and medicinal plants                        | Qualitative:<br>secondary data analysis<br>MAXQDA                    | Expert interviews<br><br>Encyclopaedia on medicinal plants of Kyrgyzstan<br><br>Relevant literature of local authors  | 2       |
| Analysis of societal changes                                  | Quantitative:<br>descriptive statistical analysis                    | Survey, national and international statistical data on economic growth, demographics, food balance sheets,  | 2       |
| 24-h diet recall  | Quantitative:<br>analysis of NAR and MAR<br>NutriSurvey              | Primary data<br><br>Individual interviews<br>Portion, ingredients   | 3       |
| Socio-economic analysis; Demographic and farm characteristics | Quantitative:<br>Mann Whitney U test, Kendall's tau correlation<br>R | Survey  | 3       |
| DDS   | Quantitative<br>Excel (mean, median, SD)                             | Survey  | 3       |

NAR stands for nutrients adequacy ratio; MAR is mean adequacy ratio; DDS dietary diversity score

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## Chapter 2. The Transformation of Food Culture on the Case of Kyrgyz Nomads—A Historical Overview

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**Abstract:** The society in Kyrgyzstan experiences a triple burden of malnutrition which occurs when undernutrition, overnutrition and micronutrient deficiency coexists, straining the public health system. This research investigates historical trends of nutrition transition of nomadic and semi-nomadic Kyrgyz and foods consumed earlier before industrialisation and intensification of agriculture started. Qualitative research design inspired by historical analysis and sociological methods were employed. Saturation sampling was used to conduct 15 semi-structural interviews and informal conversations with non-participant observation. Secondary data analysis was conducted based on Kyrgyz nomads' scientific studies from history and anthropology, agricultural politics and nutrition studies. Results suggest that Kyrgyz nomads have undergone several periods of change of social and political order since the mid-19th century till nowadays from nomadic tribe-based system to predominantly sedentarism and limited semi-nomadic lifestyle. The collectivisation of farms, urbanisation and planned type of economy led to shifts in lifestyle and diets. Furthermore, with trade liberalisation and open economy policies, the entrance of food corporations impacted the nutritional status of the population. The study also reveals several traditional foods rich in nutrients. Consumption of forgotten and neglected plants might improve the nutrition status of the current population. Nutrition intervention programs should definitely consider locally available foods as part of public nutrition.

**Keywords:** nutrition transition; nomadism; transition economies; the triple burden of malnutrition; food security; traditional knowledge; medicinal foods and plants

## 1. Introduction

In 2020, around two billion people could not have safe, nutritious and sufficient food daily [1]. Kyrgyzstan is a landlocked and mountainous country in post-Soviet Central Asia with a population of over 6 million. Inadequate and poor diet in certain parts of the population is the underlying cause for multiple health issues existing in the country. According to WHO [2], 83% of non-communicable diseases (NCDs) were responsible for deaths in 2016. At the same time, statistics show that the number of people with cardiovascular diseases increased by around 8% in the country between 2015 and 2019 [3]. Maternal and child malnutrition is one of the public health problems in Kyrgyzstan. Regardless of several economic and political crises during the last 30 years, independent Kyrgyzstan has experienced improvements in several human nutrition indicators, partly owing to nutrition intervention programs [4].

Flour fortification and Gulazyk (micronutrient powder for children under 3 and 5) have been introduced to improve the nutritional status of different parts of the population [5]. Gulazyk showed a positive result for reducing iron deficiency but was insufficient for diminishing anaemia levels for Kyrgyzstan [5, 6]. This might be due to the worsening of households' food security [5] and the growing availability of fast foods [7]. Low-income families are more vulnerable to external shocks, such as abrupt changes in food prices. For the period 1990–2017, the child malnutrition situation substantially improved, but regional inequalities remain. At the same time, maternal nutrition status has not dramatically improved for the last 20 years [4].

The coexistence of undernutrition, overnutrition, and micronutrient deficiency in a society named triple burden of malnutrition currently exists in Kyrgyzstan. Political, economic, social and cultural transformations impact the habitual lifestyle and accustomed diet of a group of people. With entering market relations, dietary changes are occurring in many societies. In a rapidly changing world, it is essential to look back and explore the different societal phenomena. As societies face political and economic transformations, how do these influence their diet? Does it stay the same or evolve with new realities? This is the underlying question driving us to understand how nomadic Kyrgyz's diet and nutrition changes have developed over the last 170 years.

Limited literature exists which discusses typical food starting the 19th century among nomad Kyrgyz. Thus, this paper aims to explore how the food culture of Kyrgyz was evolving before and during the socialist rule and during the post-independence era. The reason for choosing these historical periods is three different socio-political systems representing complex societal transformation: (1) Tribal system (Mid 19th century–1922); (2) Socialist/communist (1922–1991); (3) The market economy (1991–today).

The objectives of this article are to (i) make a historical overview of major changes which have occurred in the past 170 years within Kyrgyz communities; (ii) understand how three political and economic systems are related to nutrition transition, and (iii) explore forgotten foods and medicinal plants. Our hypothesis states that with the shift to the industrialisation of agriculture and marketisation of the economy, centuries-long consumed authentic food is under the danger of



disappearance, and the growing popularity of Western-oriented food impacts nutrition transition and health pattern of population.

## 2. Theoretical Framework

Theory of nutrition transition concerns with humanities' diet changes occurring across time and space. It derives from epidemiological and demographic transition theories that study humans' life expectancy patterns and causes of death. Humans go through five stages of nutrition transition (Figure 5), starting with food gathering when consumption of carbohydrates and fibre is high, and that of fat is low coupled with advanced physical activity and thus low obesity levels. Famine belongs to the period of extreme food shortage, settlement and cultivation of basic crops (Stage 2). Stage 3 refers to the state of receding famine when the consumption of fruits, vegetables and protein increases and carbohydrates in diets decrease. It is accompanied by increased production in agriculture and thus less physical human activity. Stage 4 is characterized by high consumption of processed foods and fibre, low activity levels and thus high obesity rates among the population. Levels of degenerative diseases also rise. Conscious attitude to nutrition coupled with a behavioural change toward a healthy and balanced diet is the last stage of the nutrition transition [8–11].

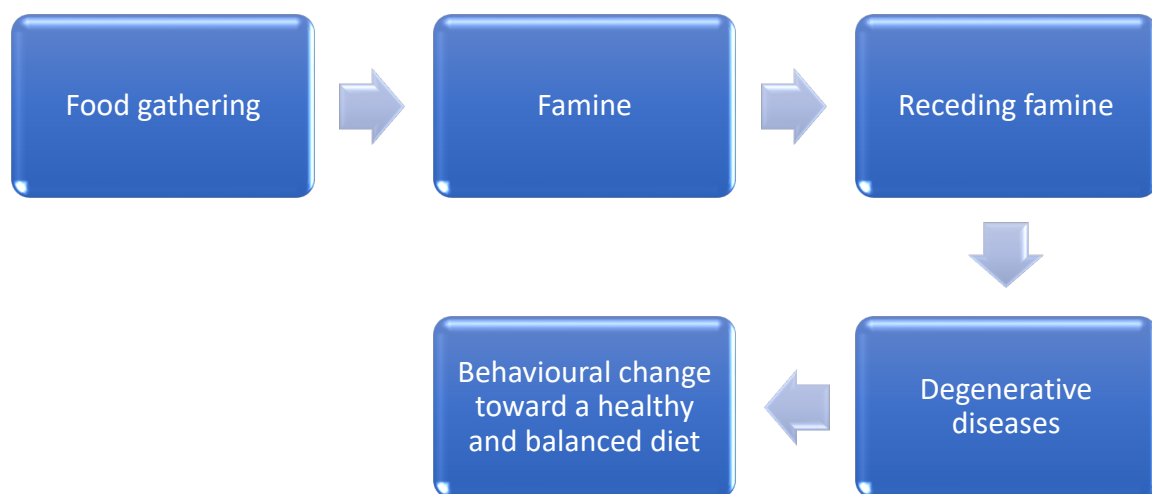


Figure 5. Stages of nutrition transition (source: authors' visualization based on the theory of nutrition transition)

Most low and middle-income countries, including Kyrgyzstan, are currently at stage four, at which the human diet consists of a high intake of oils, sugars, animal products, processed foods and sweeteners [12]. This type of diet often leads to nutrition-related non-communicable chronic diseases (NR-NCDs). The term nutrition transition connotes diet changes in which consumption of fruits and vegetables, animal products, fats and sweets increases, whereas fibre intake decreases. These transitions happen due to income improvements [13]. As the definition of this term

clearly explains changes in diet patterns, it omits background transformations taking place, leading societies to a different and unhabituated nutrition pattern. Thus, nutrition scientists focus mostly on how certain nutrients impact human health rather than exploring general political, economic and cultural settings influencing dietary patterns [14].

Nowadays, low and middle-income countries face diet changes into the so-called “Western diet” [15,16]. The term entails turning away from traditional and mostly unprocessed foods towards a high intake of energy-dense foods such as sugars, refined carbohydrates, fats and foods originating from animals [14]. These changes took place partly due to agricultural policies [15]. The well-known Green Revolution helped fight hunger and famine in many nations by increasing yields and homogenized food supplies [14].

Assumptions exist that lower and middle-income countries face the increase of obesity and NR-NCD prevalence more rapidly than that of Western countries [9]. There is a belief that urban poor tend to consume obesogenic food. This might explain the existence of hunger and obesity in the same setting [15]. The pace of the shift from a subsistence economy to industrialization in emerging economies was much faster—only within 10–20 years [9].

Kyrgyz people are known for cattle breeding as it was the primary occupation for centuries. Approximately 7–8 B.C., Kyrgyzstan’s territory was a place of numerous Turkic nomadic tribes, including the most famous Sakas and Wusuns. When health issues, such as micronutrient deficiency occur, societies need to research traditional food systems to deal with malnutrition. Scientific literature lacks data on traditional foods, making it impossible to include these valuable plants in nutrition programs [17]. Lack of awareness of traditional foods’ value, changing dietary habits, and societal beliefs concerning certain foods contribute to malnutrition [18].

### 3. Methodology

Qualitative research design inspired by historical analysis and sociological methods were employed. The research is of explanatory and exploratory nature, making attempts to study the past to understand the current state and driven by questions of how and why nutrition transition has been taking place among Kyrgyz nomads. This methodology supports a deep understanding of the ways major societal changes influence food culture. Primary and secondary data collection was employed in this study. Primary data were obtained through 15 semi-structural expert interviews, personal experiences and conversations, together with non-participant observation [19] with notes taken and statistical data from the National Statistical Committee (NSC) of the Kyrgyz Republic. The number of interviewees was reached via saturation sampling, at which we understood that an additional interview would be less likely to give new insights to our study [20]. Key informants were historians, food experts, political scientists, representatives of different ethnic groups and individuals sharing their experiences. Questions differed depending on the background of a key informant. Based on information from the primary sources, we consulted secondary sources to back up our arguments. Secondary data were based

on Kyrgyz nomads' scientific studies from history and anthropology fields, the literature of politics of the Soviet Union, agricultural policies and nutrition studies. Secondary data analysis [21] was applied while evaluating and employing these studies in the thematic network analysis. MAXQDA 2018 was used for themes and codes analysis. To ensure code reliance, two experts looked at codes.

#### 4. Results

The results of this study are based on primary and secondary data. Primary data include key informants N = 15 and statistical data on various indicators of countries' development. Table 2 provides an overview of interviewees.

Table 2. Information on key informants

| Domains                                  | Category                            | N  |
|--|-------------------------------------|----|
| Occupation/Interest                      | Agriculture expert                  | 2  |
|  | Political/historical/food scientist | 4  |
|  | Medicinal plants expert             | 3  |
|  | (Nomadic) food expert               | 6  |
| Age                                      | Under 45                            | 5  |
|  | 46 and above                        | 10 |
| Gender                                   | Female                              | 12 |
|  | Male                                | 3  |
| Regional representation                  | North                               | 7  |
|  | South                               | 8  |
| Personal experience in nomadic lifestyle | Yes                                 | 14 |
|  | No                                  | 1  |

Secondary data are based on existing nutrition literature on the region studies on the history and economy of Kyrgyzstan during the last couple of centuries.

Observing dietary changes through historical perspective and political changes among Kyrgyz nomads provides us with new insights. This part will describe how the socio-economic situation was changing during these three historical periods. Kyrgyz were predominantly nomads practising animal husbandry. Land policies and new ethnic groups brought new farming practices, new vegetables and fresh food, thus diversifying local cuisine. Together with that, Central Asia was turned into agricultural production site during the Soviet Union due to its favourable climatic conditions for growing various crops, fruits and vegetables and animal husbandry. This process has a double-sided impact on nutrition transition and the environment as the diversity of existing food became available, shifting diets towards energy-dense foods. At the same time, the intensification of agriculture led to soil degradation and water depletion. This scenario continued in the post-independence period. Table 3 demonstrates the three politico-economic systems indicating their characteristics.

Table 3. Kyrgyzstan in three periods: Pre-Soviet period, Socialist rule under USSR and a market-based economy (source: based on the literature review)

| Politico-Economic System              | Time Period                       | Characteristics   |
|---------------------------------------|-----------------------------------|---|
| Pre-Soviet                            | Mid 19 <sup>th</sup> century–1922 | Imitates feudal system (For the sake of partial explanation and generalization, we put here as “feudal system”, although it would be much explanatory to depict the setting as community-based tribal system, where a tribe consisting of one large intergenerational family each serving head of a tribe. For a detailed explanation, see [34].)<br>Lack of territorial integrity<br>Villages on the tribal system<br>The nomadic way of life<br>Agriculture (disperse)<br>Planned type of economy |
| Communist Rule under the Soviet Union | 1922–1991                         | Industrialisation of agriculture<br>Collectivization of farms<br>Settlement and semi-nomadic lifestyle<br>Urbanization<br>Market-based economy<br>Privatization and private property  |
| Liberal Economy                       | 1991–today                        | The entrance of global food labels into the local market (corporations)<br>Predominantly settled lifestyle with a very small portion of seasonal semi-nomads  |

#### 4.1. Pre-Soviet Kyrgyzstan

Kyrgyz are an ancient Turkic-speaking people first mentioned supposedly in the 3rd century B.C. [23]. The oral poetic and multifaceted musical culture of the Kyrgyz nation contributed to the maintenance of the national identity of Kyrgyz. The world’s longest epos, “Manas”, depicts both century-long fightings of the Kyrgyz with strong Mongolian nations and migration from Altai to the Tian Shan.

The ancient Kyrgyz people were well aware that proper nutrition contributes to the body’s positive functioning, helps the vital functioning of internal organs and cells, supports their constant and systematic renewal and enrichment, and is a source of energy for humans. Malnutrition, both excess and inadequate, can cause significant harm to health worsening overall well-being, negatively affecting physical and mental development, leading to fatigue, inability to resist adverse external environmental influences, decreased working capacity, and even premature ageing and shortened life expectancy. The Kyrgyz people have attached particular importance to nutrition as a critical element of national culture and a significant factor in physical and mental development. Children from an early age were brought up to a proper nutrition

culture, taught to distinguish good, high-quality food from bad and low-quality, taught to cook nutritious and delicious dishes.

The traditional nutrition system of the Kyrgyz is based on nomadic animal husbandry of mountainous geographical zones [24]. Nomadism is a way and a result of adapting to the natural and economic situation [25]. The common belief that nomadic tribes' diet was originated only from animal sources is fallacious. Findings suggest that their diet was based on a complex pastoralist system involving agriculture [26]. Ecological circumstances, namely, availability of water resources, precipitation, location and others, defined agricultural activities. Among others, foxtail millet (*Setaria italica*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), broomcorn (*Panicum miliaceum*), even grapes (*Vitis vinifera*) were particularly part of Central Asian nomad's diet in the Early Iron Age [26,27]. This was partly possible due to the existence of irrigated agriculture.

The economy of Kyrgyz was generally comprehensive. The second place after cattle breeding was occupied by almost everywhere widespread agriculture. For many mountainous regions, it was characterised by peculiar features of nomadic agriculture [28]. Applied artfully and developed a very long time ago, irrigation techniques adapted to high altitude conditions. Irrigation ditches called *aryk* were often arranged at high altitudes, in the rocky ground with a stone bed. The irrigation system allowed nomads, after sowing, to move to pastures and return to harvesting. Depending on precipitation, irrigated agriculture was combined with rainfed [28].

Traditional food items included fermented beverages and some locally grown crops. *Kymyz* (koumiss, kumiz) is a traditional drink made of fermented mare's milk. Cereal-based fermented drinks such as *maksym*, *bozo* and *jarma* belong to national beverages (Table 4).

Table 4. List of foods consumed by Kyrgyz (based on [29,30])

| Name in <i>Kyrgyz</i> | Ingredients   | Explanation   |
|-----------------------|---|---|
| <i>Kurut</i>          | Cottage cheese  | Dried hard cheese                                   |
| <i>Maksym</i>         | Oat flour/barley  | Beverage  |
| <i>Bozo</i>           | A fermented drink made of millet, maize, barley and wheat | Beverage  |
| <i>Jarma</i>          | Barley/wheat, flour, malt                                 | Cold beverage                                       |
| <i>Talkan</i>         | Barley/wheat/corn   | Oatmeal mixed in water, milk or curdled milk        |
| <i>Botko</i>          | Millet  | Porridge  |
| <i>Kymyz</i>          | Fermented mare's milk                                     | Every day drink of a Kyrgyz nomad                   |
| <i>Byshtak</i>        | Milk  | A type of fresh and cottage cheese from boiled milk |

The main elements of the nutrition system remained until the beginning of the 20th century. Socio-economic changes inevitably influenced food and nutrition transitions. Economic, cultural and interethnic integration processes played a significant role in the nomad Kyrgyz's nutrition and food system [24]. Before the

Russian annexation, the Kyrgyz people were already consolidated as a nation. Discovered archaeological findings on Kyrgyzstan's modern territory show the existence of rich and diversified culture [28]. Heavy physical activity such as cattle grazing, preparation of dry fodder manually was an essential part of livelihood. Traditions and rituals were used as a healing method both for humans and cattle. Horse or sheep meat was consumed not by one family, but it was fairly distributed by each member of an extended family or even a tribe. This tradition shows that nomads cared for the health and nutrition of each tribe and family member. Thus, the social justice principle was presently securing the politics and security of the tribe [31].

The Russian and Ukrainian peasants positively influenced local agriculture [28], as they shared their practice and experience of fishing, beekeeping, growing and other agricultural practices with the Kyrgyz farmers since the 1860s and 1870s. The share of agriculture has long been higher in the economy of southern Kyrgyz. In Northern Kyrgyzstan, its importance began to increase after the entry of Kyrgyzstan into Russia [28]. Part of the impoverished households with a small number of cattle have switched to agriculture. For many low families with no livestock at all, farming has become the only source of livelihood. Under the tsarist agrarian policy, the transition to agriculture and poor Kyrgyz was often forced and proceeded far from painlessly [22].

In the colonial context, the term "tribe" is connotated with underdeveloped or primitive. Kyrgyz tribes, similar to those of other regions, had strong tribe identification in private and social life. The kinship and tribal system of Kyrgyz was a form of social organisation. Feudal and patriarchal governance systems consisted of *manap*, *datka*, *biy* (elite) and *kedey* (poor) [32]. Along with home crafts, hunting also played a prominent role in the Kyrgyz people's economic structure, in which the ancient features (collective hunts, hunting with birds like eagles) stand out distinctly. *Aiyl*, a village, represented a small group of dwellings where close relatives resided together as a community. A *yurt* was a traditional housing that could be easily disassembled and transported [29]. Kyrgyz were well aware of the plant cultures that grow in the arid and semi-arid areas they inhabited [33]. The introduction of land ownership and being attached to a particular geographical setting was unfamiliar to the nomad Kyrgyz. For him or her, the land was associated with belonging to a tribe, group of people or a state [34].

### *Foods Including Drinks and Medicinal Plants*

Observed literature on nutrition suggests that Kyrgyz nomads' diet consisted of meat, dairy and some grain varieties. Fruits and vegetables have almost no mention in the scientific works. "Did nomads consume them at all?" is a question that drove us further to study the question of nomadic nutrition. Today we know that the territory of Kyrgyzstan is highly biodiverse. Wild fruits and nuts grow in Kyrgyzstan, including cherry plums, pears, apples, apricots, pears, grapes, almonds, pomegranates, walnuts, pistachios, etc., as well as wild crops of wheat, rhubarb, garlic, onion, anise, sorrel and oats [35]. We assume that Kyrgyz nomads have well

consumed all these wild fruits and vegetables to fulfil nutritional demands and for medicinal reasons.

Bozo is a low alcohol traditional fermented beverage made of millet, maize and barley and wheat [30]. Gulazyk (or kulazyk) is a traditional powder-like, micronutrient-rich, dry and easily transportable food. Kyrgyz travelling long distances would take them for their journey as it obtained property of not getting rotten for several months. Exact ingredients are forgotten, but the powder consisted of meat, flour, grasshopper and other nutritious substances.

The development of urban areas has lessened the role of medicinal plants and increased reliance on modern medicine [36]. The utilization of plants for nutritional and medicinal purposes is an ancient tradition. Traditional medicine uses many medicinal plants that were not enlisted in the official encyclopedia but have been used traditionally. Thanks to climatic and geographical conditions, Kyrgyzstan is rich in medicinal plants (Table 5). Most likely that Kyrgyz ancestors used them for nutritional as well as therapeutic purposes.

Table 5. Plants of Kyrgyzstan used in traditional medicine [37, 38]

| Botanical Name  | Name In Kyrgyz                               | Parts Used and Preparation                          | Health Properties   |
|---|--|---|---|
| Angelica<br>Brevicaulis (Rupr.)<br>B. Fedtsch                       | Kyska sabattuu<br>kerech                     | Decoction of herbs                                  | Sinks blood<br>pressure, diuretic   |
| Arum Korolkowii<br>Regel  | Korolkov arumu;<br>kuchala                   | Tuber tincture,<br>small doses (toxic)              | Libido boosting   |
| Codonopsis<br>Clematidea<br>(Schrenk.) Clarke                       | Koguroodoj sasyk;<br>boor chöp               | A decoction of<br>herbs in small<br>amounts (toxic) | Liver problems  |
| Cysticorydalis<br>Fedtschenkoana<br>(Regel) Fedde Ex<br>Ikonn.      | Fedchenko örmö<br>karasy                     | Root extract  | Arthronosos,<br>tumor   |
| Dactylorhiza<br>Umbrosa (Kar. &<br>Kir.) Nevski<br>(Orchis Umbrosa) | Kölököl arala                                | Decoction of buds                                   | Respiratory tract<br>inflammation,<br>gastritis, diarrhoea,<br>paralic, cramps,<br>cough,<br>tuberculosis,<br>digestion, hair<br>growth |
| Dictamnus<br>Angustifolius G.<br>Don Fill. Ex Sweet.                | Ichke jalbyraktuu<br>diktamnus;<br>shakyldak | Root extract  | Kidney<br>inflammation  |
| Korolkowia<br>Sewerzowii Regel                                      | Severcov algysy                              | Decoction of buds                                   | Gastrointestinal<br>disease   |
| Ferula Kokanica<br>Regel Et Schmalh.                                | Kokon chajyry                                | Decoction of herbs                                  | Asthma, headache,<br>fatigue, nervous<br>agitation  |

|  |                            |   |  |
|--|----------------------------|---|--|
| Perovskia<br>Scrophulariifolia<br>Bunge              | Norichniktej koen<br>tomuk | Tea from its dried<br>flowers                                       | Gastrointestinal<br>disease  |
| Rheum<br>Maximowiczii<br>Losinsk.                    | Maksimovich<br>yshkyny     | A decoction of<br>roots and leaves                                  | Leaves decoction<br>for digestion; root<br>extract for against<br>worms for children       |
| Scrophularia<br>Kiriloviana<br>Schischk.             | Gazzak chaj                | Decoction of herbs  | Gums issues,<br>stomatitis   |
| Leontopódium<br>Alpínium                             | Mamyry                     | A decoction from<br>dried flowers                                   | Detox effect,<br>strengthens the<br>immune system,<br>diarrhoea                            |
| Mumijo (Shilajit)                                    | Mumijo                     | Organomineral<br>product<br>biologically<br>sourced                 | Bones, digestion   |
| Aconitum<br>Leucostomum<br>Worosch—<br>Ranunculaceae | Uu korgoshun, ak<br>kodol  | Toxic, dried roots<br>used, used with<br>traditional drink<br>kymyz | Rheumatism,<br>radiculitis,<br>antibacterial effect,<br>arthrosis, podagra,<br>brucellosis |
| Thymus   | Kijik ot                   | Decoction of leaves   | Diuretic, digestion,<br>heart and lung<br>issues   |

## 4.2. Dynamics under the Soviet Planned Economy

### 4.2.1. Settlement of Nomads and Urbanisation

The Soviet government attached great importance to the settling of nomads. The collectivisation of agriculture brought fast transformations to society. As a result of the allocation of considerable funds, in just three years (1932–1934), 34,500 nomadic and semi-nomadic Kyrgyz farms were transferred to settle [28]. Urbanization was developing together with the establishment of new settlements of Slavic peasants from Russia. The northern part of the country's favourable climate, fertile soil and arable land attracted these peasants. North Kyrgyzstan turned into multi-ethnic urban centres [34]. Impoverished Kyrgyz then began to settle in Bishkek by becoming labourers to Slavic peasants. Deprivation of pasture lands led to continuous conflicts with the local population. Characteristics of these changes include:

- Communal ownership of resources;
- Establishment by Russian peasants and setting new administrative units led to the disruption of the accustomed social order of Kyrgyz nomads;
- Nomad Kyrgyz had to adjust to new administrative and political orders [34].



The process of settlement and urbanisation of nomads was implemented in a forced manner. Tribe leaders' cattle and livestock were taken away, forcing them to abandon their settlement and escape to China regardless of hard winter periods. The unification of previously scattered families in one village led to the development of new forms of life, to the restructuring of industrial and domestic life [28]. At the same time, agricultural reforms, including the formation of collective farms, and technological advancement, increased agricultural production.

#### 4.2.2. Food and Agricultural Policies under a Planned Economy

Social policies introduced by the Soviet government played a considerable role in the health and nutrition of Kyrgyz nomads. The development of public social health was based on the idea of insurance for all and vaccination. These measures led to the decrease in child mortality, an increase in population, and prolonged life expectancy (see supplementary materials). Universal access to education guaranteeing that every child attends primary school improved the literacy rate substantially among the population. Welfare-oriented policies, including developing and implementing public nutrition standards and programs, impacted nomadic food culture. Industrial production of food, processing, and marketing led to increased food supply [39].

In the 1960s, Khrushchev's policy on increasing meat and milk products and reducing potato and bread consumption was launched [39]. Substantial subsidies to meat and dairy products were made to increase the production of these food items. In the Soviet Union, diet changes began in the 1960s. Food policies led to the increase in consumption of meat, milk and sugar and a decrease in bread and potatoes in diet during 1950–1989 (see Supplementary materials) [39]. We assume that similar diet changes happened in Kyrgyzstan as well, as these food policies spread for the entire country. Their long-term effects will be discussed later in this article. During the Soviet Union, nutrition data collection was based on household food expenditure and purchases relatively, which was then converted into nutrients. Lack of systematic research and representative data [39] makes assessing different parts of the population's nutritional status challenging.

Agricultural policy towards Kyrgyzstan was aimed at increasing farm animal production due to its environmental and traditional reasons. During the Soviet rule, the country's number of sheep reached its record level—over 11 million heads [40]. Availability of pastures depends on climatic conditions ranging from 2.3 million ha in winter to 3.9 million ha in summer. As a result of the planned type of economy, overgrazing, land intensification and pasture degradation took place. Traditional practices on pasture management were neglected and forgotten from generation to generation [40]. Constituting mainly animal production, a growth rate of gross agricultural output increased substantially between 1940 and 1975 (Figure 6). Technological advancements in agriculture (Figure 7) took place, increasing per capita production in the country.

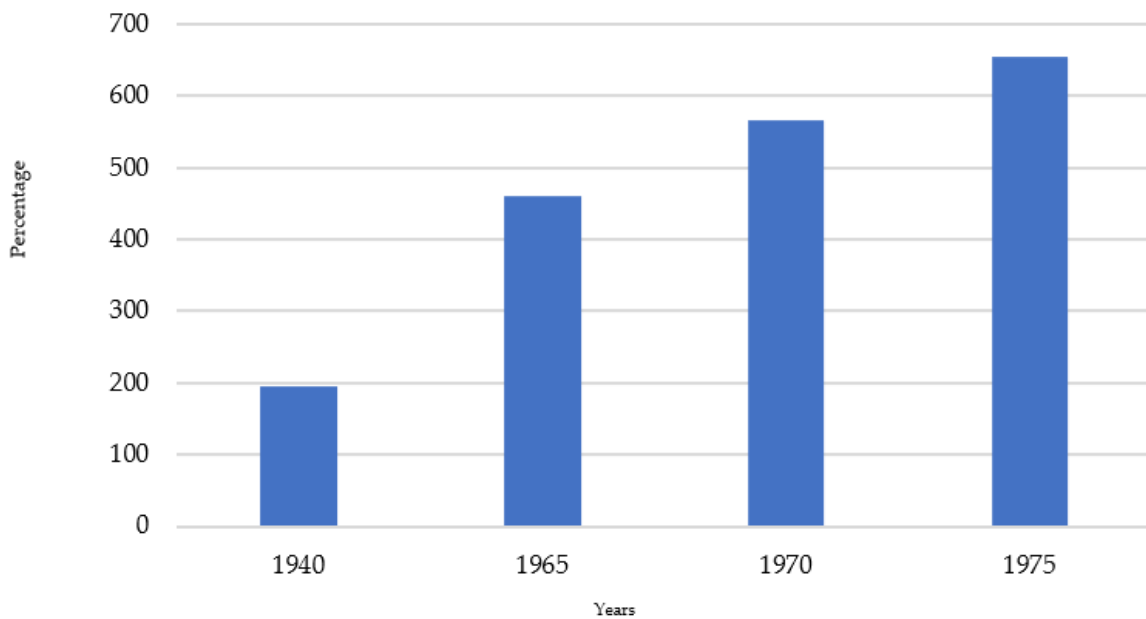


Figure 6. The growth rate of gross agricultural output in Kyrgyzstan for 1940–1975 years (in %, 1913 = base) [41]

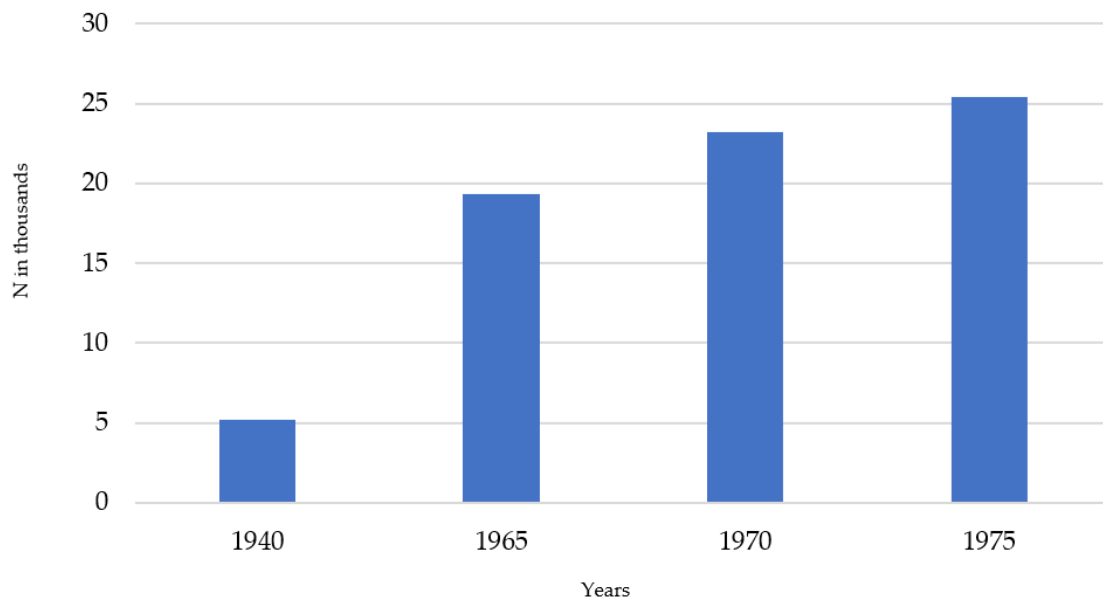


Figure 7. Number of tractors in agriculture (in thousands) [41]

Markets were interconnected within the Soviet Union, and prices were state-controlled. Thus, markets for agricultural products from Kyrgyzstan were guaranteed at state price [42]. During 1950–1970, sugar consumption, dairy products and red meat increased rapidly, whereas cereals and starchy tubers intake decreased in the Soviet Union. On the other hand, consumption of vegetables, eggs, vegetable oil, fruits and fish increased in the whole Union [39]. We assume that these diet changes were common for the entire country, as Kyrgyzstan was part of the Soviet Union.

After the Russian Revolution and Soviet’s policy on agriculture and land-water reforms, nomadic and semi-nomadic Kyrgyz households gradually settled down. As

a result, seasonal character of food, social differences in quality and quantity of food, and subsistence farming dependence are weakened [29]. The changes in the Kyrgyz people's economic structure that came soon after the accession of Kyrgyzstan to Russia led to a noticeable increase in the diet share. In the subsequent period, the main types of food for most of the Kyrgyz population became dairy and vegetables, and only partially meat. Objective observers have long noted that beef was a luxury item for most Kyrgyz people and was only wealthy people's daily food.

#### 4.2.3. Different Settings in the North and the South

Historical developments in northern and southern Kyrgyzstan have some differences [29]. The Fergana valley lies in the southern part of Kyrgyzstan. The formation of populated Kyrgyz settlements began earlier because of interaction and trade relations with settled ethnicities such as Tajik and Uzbek. Several villages appeared only at the very end of the 19th century in the northern part. Their emergence resulted in new socio-economic conditions caused by the entry of northern Kyrgyzstan into Russia and the positive influence of the Slavic migrant peasants who appeared here [28]. For almost a century between the end of the 18th century and 1876, the Kyrgyz of Fergana valley was ruled by the Kokand Khanate. The Kokand figuratively ruled the Kyrgyz of the northern tribes residing on Issyk Kul lake's banks and rivers of Talas, Chu, and Naryn, but mostly by *manaps* tribal leaders [34].

Developed agriculture has existed in the Fergana Valley since the second half of the 1st century B.C. Materials collected on the valley Tian Shan prove that Kyrgyz practised irrigated agriculture in the 17th–18th centuries [28]. Kyrgyz have knowledge of cattle breeding which was transmitted from generation to generation. The annexation of Kyrgyzstan to Russia resulted in a substantial increase in grain production due to agricultural development. New sectors started to develop, such as gardening, horticulture, beekeeping, and poultry farming, but traditional food and cooking remained almost the same [24].

Agriculture was an integral part of the entire economic structure of the Kyrgyz population in Osh oblast. The Kyrgyz cultivated wheat, corn, rice, melons, and alfalfa in the south. The complex nature of the economy in the pre-revolutionary period largely influenced the formation of southerners' nutritional characteristics. At the same time, the food of Kyrgyz of Issyk-Kul and Naryn zones was based on animal products such as meat and dairy. In addition, they grew wheat, millet, barley, a small number of oats and alfalfa for self-consumption [24].

Families' nutrition in locations where Russian and Ukrainian settlers were present differed from those in Osh or Naryn oblasts. The former's diet included fish, sausages, meat products and typical Russian-Ukrainian products such as borscht (cabbage, vegetable, meat soup), vareniki (dumplings), potato-based dishes, poultry. In contrast, families in the Osh region included foods traditional Kyrgyz and some Uzbek foods such as *shorpo* (meat soup), *plov* (rice, carrot and meat second dish), *kesme* (noodles), *lagman* (hand-pulled noodles with meat and vegetables), *manty* (a bigger type of dumplings filled with meat and/or vegetables). Meat and noodle-based foods such as *gulchotai*, *besh barmak*, *manty*, *oromo* are predominantly consumed in the Naryn

region. Traditional drink consumed in the summer season includes *jarma* (crushed roasted grain, wheat or barley stew), *maksym* (a sour drink made from crushed barley without malt), *bozo* (hop drink) and *kymyz* (fermented mare's milk) [24].

### 4.3. Kyrgyzstan Enters a New Era of Independence

The transition from planned type of economy to market-based economic system affected food choice and its price. The collapse of the previously existing value chain ranging through different countries within the Soviet Union led to the rapid decrease of products for a short period of time. It also caused the destruction of water management and irrigation systems existing in Central Asian countries [33]. Moreover, excessive use of natural resources and poor management practised before continued after its fall worsening ecological situation. For instance, nitrogen (N) usage had increased from 9200 tons in 1997 to 24,000 tons in 2017. In contrast, phosphorus employment (P<sub>2</sub>O<sub>5</sub>) raised from 200 tons to 1400 tons for the same period in Kyrgyzstan [43]. This takes place due to the uncontrolled usage of chemicals and pesticides.

At the beginning of the 1990s, as the newly formed state, Kyrgyzstan faced a short period of a rapid decline of crop and livestock production in provinces. As a result, lack of available food items shifted dietary changes towards basic and affordable foods [42]. This lasted till the mid-1990s when food availability improved again after a short period of market restructuring. However, research shows that energy deficiency was not an issue in 1993. On the contrary, the adult population consumed around 30% more fat than the recommended level [44]. This is probably the result of the Soviet's food policies promoting energy-dense products through subsidizing meat and milk products.

According to the theory of nutrition transition, economic growth impacts change in diet pattern. Kyrgyzstan experienced GDP per capita growth from 1990 to 2019 with a short period of economic decline in the end of the 1990s as an effect of the financial crisis in Russia (Figure 8). Economic development changes employment patterns. Therefore, eating out has become popular in many societies.

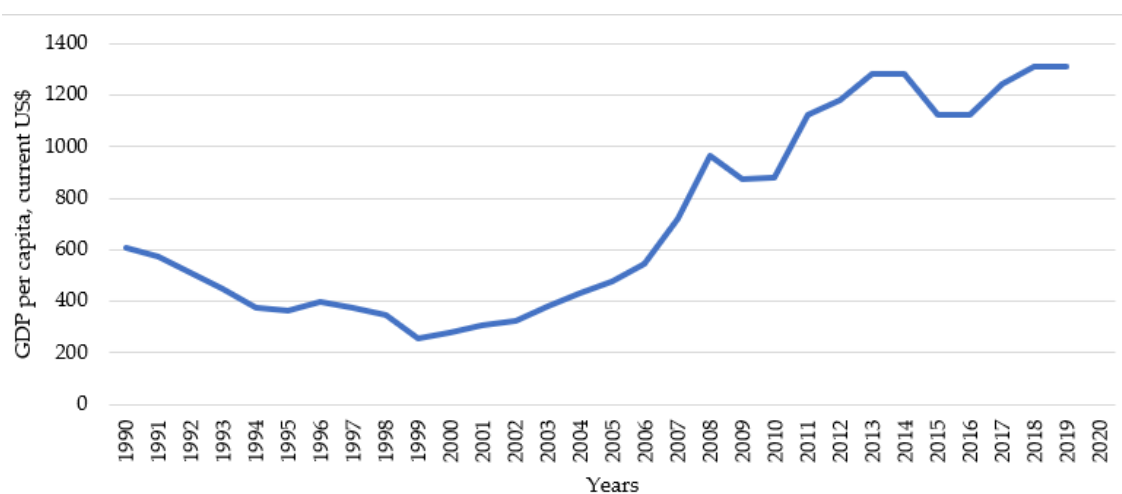


Figure 8. GDP per capita Kyrgyzstan in current USD [45]

With the gradual opening up of the market, new products such as global food corporations started to appear on the table of wealthy people. Similar to the Sri Lankan experience, consumption of these imported food items was considered a sign of luxury and thus fashionable [46]. Trade liberalisation has had a positive impact on nutrition in that it diversified food items became available to the population [14]. Due to free trade, loosening barriers for trade and food corporations' entrance in the new marketplaces, new food products, mainly highly processed, have become available to the population [16]. However, it makes traditional foods less attractive, making highly processed food products more desirable [14].

Studies exploring diet change in transition economies discover that economic transition has increased chronic diseases and unhealthy diets [48]. A similar pattern is evident in Kyrgyzstan as well. Statistics show that the rate of change of non-communicable diseases in Kyrgyzstan since independence increased (Figure 9), whereas the rate of change of communicable diseases for the same period mostly decreased (Figure 10).

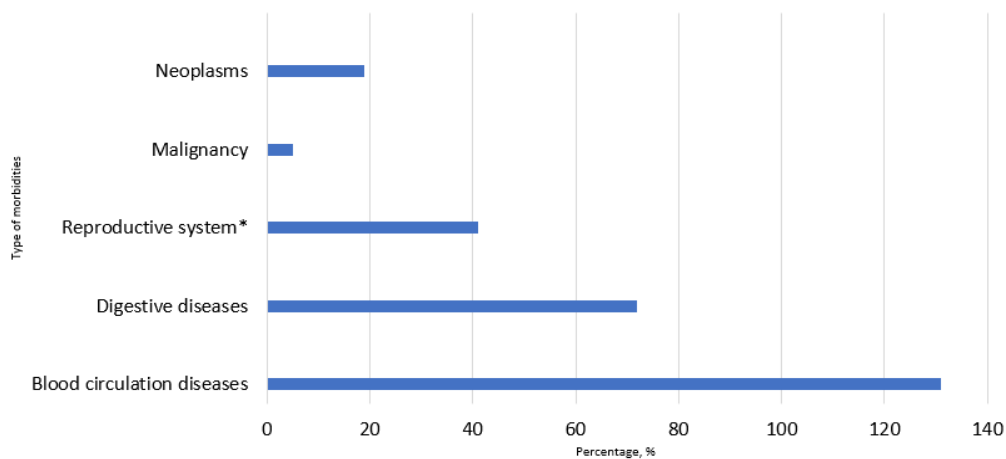


Figure 9. Rate of change of non-communicable diseases in Kyrgyzstan 1990–2019 (based on [48]) \* Data for 1991

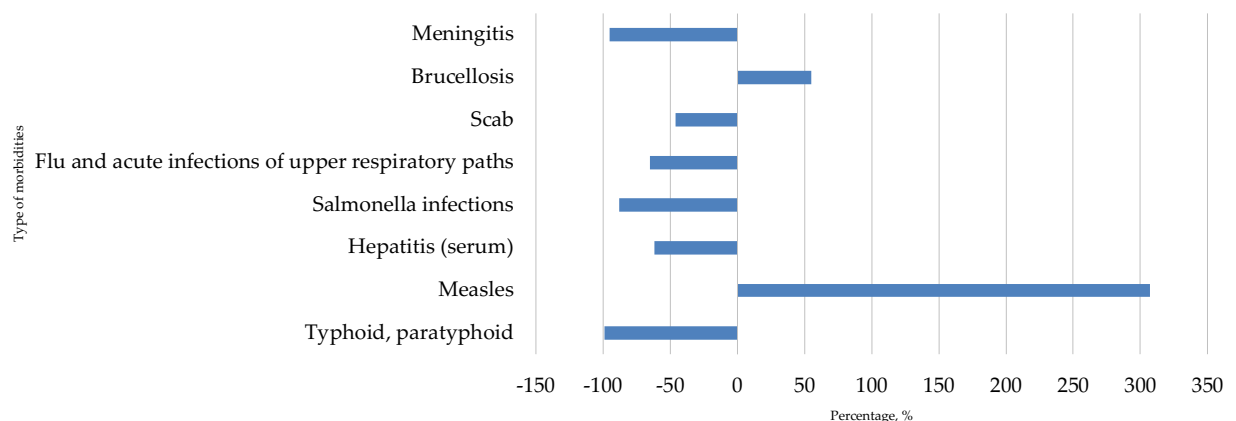


Figure 10. Rate of change of communicable diseases in Kyrgyzstan 1990–2019 (based on [48])

This shift from infectious diseases to non-communicable diseases is a trend taking place in many societies experiencing economic growth. The food balance sheet since 1990s demonstrate that processed and energy dense food products increased in Kyrgyzstan. Since the population extracts more energy from fats and carbohydrates and is less physically active, the development of non-communicable diseases such as diabetes mellitus, heart problems, and cancer increases.

A nutritious, diverse and healthy diet is an effective method to sustain micronutrient balance [5]. The nutrition transition is accompanied by decreasing fibre intake consumption as household income increases [39]. Dietary data collected among Kyrgyz adults in 1993 show that fat consumption was 30% higher than recommended levels, whereas protein intake was adequate. Low BMI was detected among adults aged 18–29 and people over 60. About 5% of people in these age groups can be considered as under nurtured. However, obesity was a bigger problem than undernutrition. 16% of adults aged 40–49 and 8% of 30–39 age groups were obese. Almost half of the respondents in the age group of 40–59 were overweight (BMI > 25.0). A total of 47% of the elderly were overweight. Women were especially prone to overweight and obesity. A study conducted in 1993 shows that obesity was a bigger problem than undernutrition in Kyrgyzstan [39].

Statistics show that the prevalence of anaemia among women of reproductive age increased during the period 2000–2016. Availability of imported highly processed foods might be a reason for the rising in obesity among adults (Figure 11).

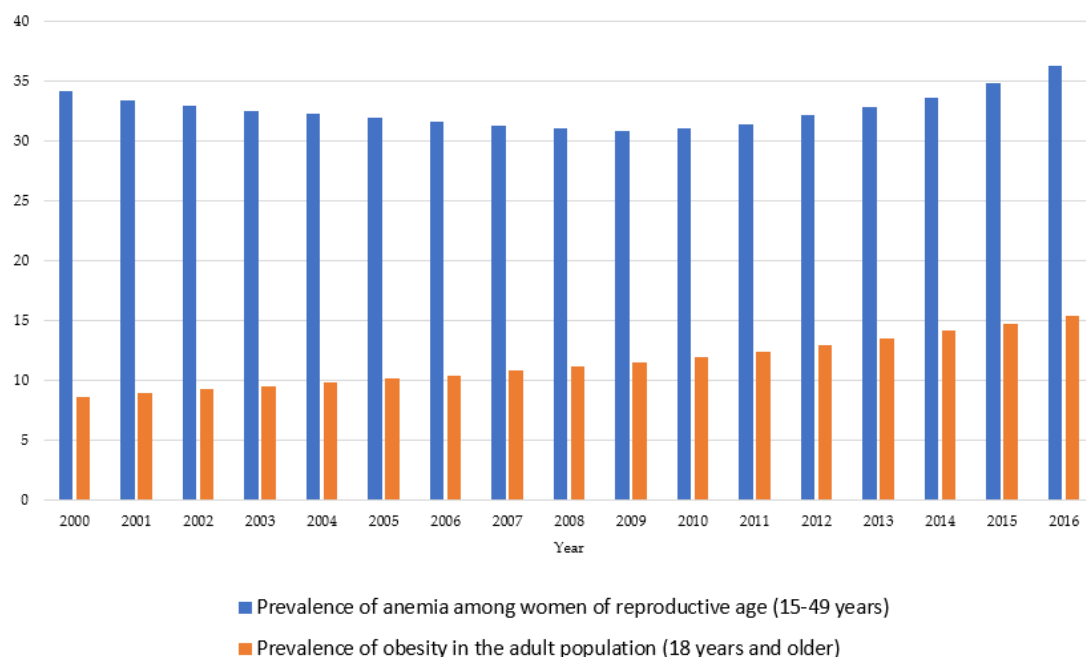


Figure 11. Prevalence of anaemia and obesity in Kyrgyzstan [43]

Kyrgyz dietary patterns have changed for almost the last 30 years. The food balance sheet from 1992 until 2018 demonstrates that per capita supply increased for certain food groups such as rice, potatoes, milk, beans, nuts, sunflowerseed oil, vegetables, fruits, and fats. It showed a slight decrease with short increases in some years for wheat products, sugar, and meat (Figure 12). Energy intake for oils increased

significantly from 20 kcal per person per day in 1992 to 99 kcal in 2018. Consumption of milk also increased from 270 kcal to 363 kcal per capita per day for the same period. The same trend is noticeable for rice and potato products from 17 and 125 kcal in 1992 to 43 and 172 kcal, respectively, for 1992–2018.

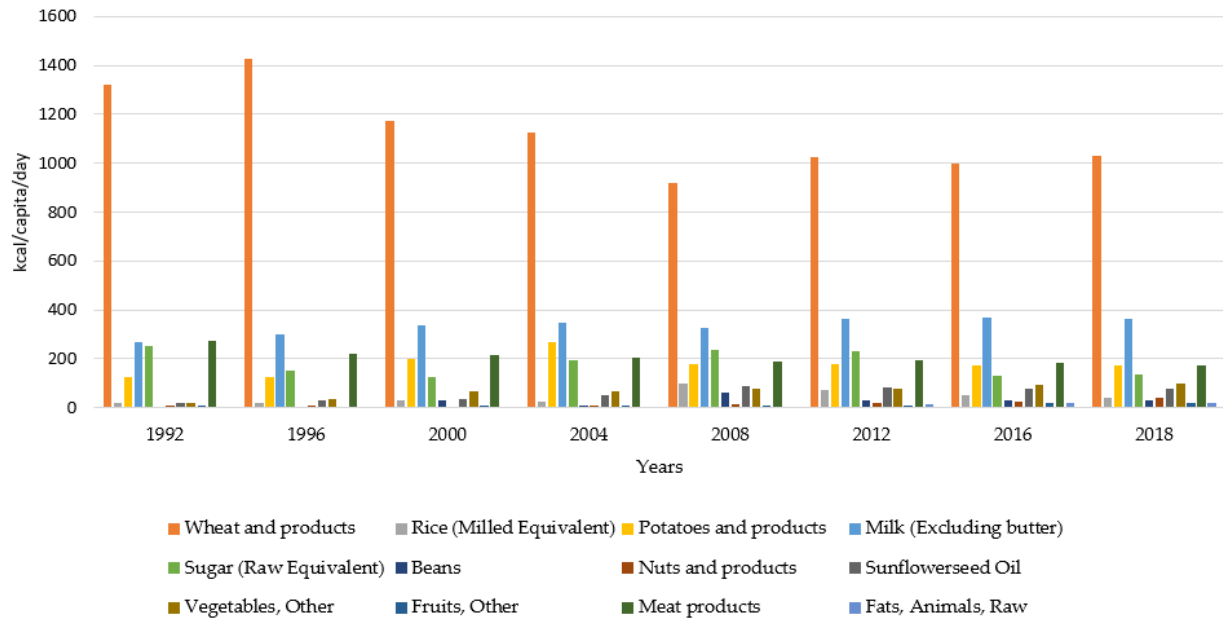


Figure 12. Food supply, Kyrgyzstan, 1992–2018 [49]

The results show that consumption of fat, carbohydrate and some animal-based products increased significantly over the last 30 years. Such diet practice coupled with limited physical activity leads to nutrition-related non-communicable diseases. Theory of nutrition transition states that during stage 4, infectious diseases decrease and non-communicable morbidities increase. This trend is obviously happening in Kyrgyz society (Figures 9 and 10), partly owing to the increasing levels of obesity among the adult population (Figure 11).

## Environmental Consequences

One of the legacies of Central Asia inherited by the Soviet planning is the Aral Sea’s ecological catastrophe.

The plan to divert the main rivers of the Amu Darya and the Syr Darya was meant to increase food and cotton production leading to negative environmental consequences [50]. At the same time, besides the disastrous impact on the Central Asian region’s ecology, the Soviet Union left unaffected walnut forest areas with some species of wild fruits. The Soviet Union perceived nut forests as an economic commodity [51]. However, wild forest plants have low productivity levels and depend on seasonal changes [52]. Among others, forests are significant sources for populations’ nutritional security [35]. Communities living near these forests can gain significant nutritious value from wild plants and trees.

## 5. Discussion

Based on the observed literature and interview results of this research study, we believe that each politico-economic system that the Kyrgyz society has gone through in the past 170 years impacted nomadic food culture. Popkin's framework of nutrition transition explains the stages of Kyrgyz nomads' transformation of food and diet changes. Table 6 demonstrates a general trend of nutrition transition taking place among Kyrgyz nomads. Each political period is not associated with the respective nutrition stage, but rather it is intended to show peculiarities each political system entails in relation to diet, lifestyle, agriculture, and economy.

Table 6. Characteristics of nutrition transition stages in three politico-economic systems (prepared based on the literature review).

| Food and Nutrition Stages | Pre-Soviet Period  | Soviet Union  | Independence Era   |
|---------------------------|--|---|--|
| Food Gathering            | Cattle breeding, food gathering, hunting was predominant occupation of local nomads.   | People residing in rural areas continued food gathering to a lesser extent; cattle breeding became the predominant occupation. Reliance on social policies lessened the need for it.          | Extremely limited in rural areas. Commercialisation allows knowledgeable/certified people to gather wild plants for income-generating purposes.                                      |
| Famine                    | Harsh weather conditions during winter, tribal conflicts, cattle looting were taking place occasionally, leading to widespread hunger and starvation                     | The collectivisation of farms, large scale food production, food policies reduced famine substantially, except for the period of WWII when lack of food and other resources led to starvation | Hunger exists in very poor settings, in peri-urban and slum areas.   |
| Receding Famine           | Similar to the previous stage; locals nurtured themselves from traditional foods and wild plants, fermented beverages; limited irrigated and rainfed nomadic agriculture | Agriculture intensifies, per capita food production increases due to technological advancement; development of public nutrition; government subsidies for animal-based products               | Intensification of agriculture continues; break down of farms collectivisation; small-scale farmers enter market relations; uncontrollable usage of artificial inputs in agriculture |
| Degenerative diseases     | Degenerative diseases did not exist because of a diet based on fibre, less fat and much physical activity  | Since data are not available, it is hard to make an assessment  | The number of communicable diseases diminishes, whereas the rates of non-communicable (e.g., cancer, cardiovascular diseases, diabetes etc.) increase                                |

Besides daily physical activity, the traditional Kyrgyz diet included low fat, high complex carbohydrates and fibre [53]. One of the most characteristic features of the Kyrgyz diet was its seasonal nature [32]. In the warm season, food was based on dairy products, while in winter, food from flour and grain and meat prevailed, to which some milk products were added (cheese, butter, salted cottage cheese) [31,36]. Most of the population's concern was constant malnutrition, especially in winter; real hunger often ensued during the mass death of cattle. "Indigenous nutrition can be



described as culturally and bio regionally specific food-related knowledge that results in a dietary pattern meeting basic nutritional needs while avoiding Western diseases” [53 p. 421]. Low in calories but nutrient-dense food are characteristics of the traditional diet of some people. On the contrary, the modern diet consists mostly of calorie-dense and nutrient-poor food. Wild foods can be rich in nutrients in comparison to cultivate plants [53]. Although data on decades’ long consumption of certain food groups is unavailable, recent nutrition data suggest that diet changes are taking place. Consumption of cereals, roots and tubers is declining, whereas foods originating from the animal have increased from 2012–2018 [54].

A typical nomad’s diet includes *kymyz* as an essential part of tradition and hospitality. Fermented food products have several benefits for human health. *Kymyz* has numerous health and nutritional properties due to the high content of vitamin A and phospholipids [58]. Modern science has proven that the consumption of *kymyz*, among others, decreases risks for cardiovascular diseases thanks to its bacterial composition [56,57]. Mare’s milk can also be quite nutritious for child nutrition [55]. In fact, similar to Mongols, Kyrgyz children consume *kymyz* from an early age. Rice is a hearty starch food after wheat in the Kyrgyz diet. Locally grown, *Ozgon rice* is red-brown colour rice with a unique taste, rich in minerals and micronutrients. Its speciality lies in local climatic conditions, soil content and farming [59].

Different historical developments in the northern and southern parts of the country had impacts on diets. Although division on three socio-economic periods is essential, regional food culture differences have their peculiarities [24]. Recent findings in the diet of the population of two regions revealed that northerners consume more meat, processed foods, fewer fruits and vegetables and more sugary food and drinks per day than southerners. This might be the reason for higher NCD rates among northerners in relation to the people living in the south. For the period of 2003 to 2018 number of obese people in the north increased from 95 to 368 per thousand people, whereas for the same timeframe, obesity in the south decreased from 35 to 26 per thousand people. Strokes also happen more frequently in the north (1282 persons) in comparison to the south (663 persons) per thousand people [54]. This might be due to the history of agriculture in the regions and ethnic composition, which influenced food culture.

Kyrgyzstan’s walnut forests are rich in nutritious plants that are rarely used by local communities [52]. Scientific evidence on the nutritional value of wild plants of Kyrgyzstan’s walnut forest is limited for the moment [61]. Wild edible plants include wild apple, wild cherry or cherry plum, pistachio and almonds, barberry, wild pear [35], wild apricot, wild onion, black salt, sea buckthorn, brier, rhubarb and hawthorn, while even insects such as grasshopper were consumed. From the fruits of hawthorn, jams were made, and its dried leaves were used for tea. Morels are rich in proteins and minerals with low calories and are nutritious [60]. Most of them are mentioned in Table 7 with indications of nutrition value that have been studied before.

Studies on the nutritional values of locally available foods showed exciting insights. *Ozgon rice* (*Oryza sativa*), named after the cultivated place, is notable for its taste, colour, odour, and physical and nutrient composition [59]. Wild cherry plum

has black, yellow, and red varieties and grows as a shrub or a tree in Kyrgyzstan's natural walnut forests. 26.4% of daily required iron can be obtained from 100 g of fresh wild cherry plum [61]. These wild berries and plants were probably consumed by nomads to meet nutritional needs and could be consumed nowadays to fight existing micronutrient deficiency among the local population.

Table 7. Nutritional composition of some food varieties in Kyrgyzstan [60-63]

| Plant Varieties         | Vernacular Name  | Botanical Name  | Nutritional Value (Per 100 g)   |
|-------------------------|------------------|---|---|
| Grains                  | Ozgon rice       | <i>Oryza sativa</i>                                     | Moisture 9.23 mg, Carbohydrate 79.86 mg, Protein 8.53 mg, Fat 1.28 mg, Mg 55 mg, Ca 17.17 mg, K 55 mg, Fe 27.58 mg                                    |
| Wild Fruits and Berries | Wild cherry plum | <i>Prunus divaricata</i> Ledeb.                         | Moisture 85 g, Potassium 128 mg, Calcium 14 mg, Copper 1.11 mg, Phosphorus 9 mg, Zink 0.18 mg   |
|                         | Wild apples      | <i>Malus sieversii</i>                                  | Moisture 80.79 mg, Fibre 1.77 mg, Natrium 3.1 mg, Kalium 15.16 mg, Mag 1.95mg, Ca 12.43 mg, Mn 0.53 mg, Fe 2.32 mg, Cu 0.35 mg, Zn 0.18 mg, P 0.67 mg |
|                         | Wild pear        | <i>Pyrus korshinski</i>                                 | Moisture 70.18 mg, Fibre 8.76 mg, Na 2.42, K 177.54, Mg 2.21 mg, Ca 4.02 mg, Mn 0.49 mg, Fe 2.7 mg, Cu 0.81 mg, Zn 0.5 mg, P 6.92 mg                  |
|                         | Hawthorn         | <i>Crataegus spp.</i>                                   |   |
|                         | Rosehip          | <i>Rosa canina</i>                                      | Moisture 70.38 mg, Fibre 4.08 mg, Na 26.24 mg, K 403.62 mg, Mg 55.38 mg, Ca 213.32 mg, Mn 6.24 mg, Fe 2.34 mg, P 21.65 mg                             |
|                         | Barberry         | <i>Berberis oblonga</i>                                 | Moisture 58.86 mg, Fibre 5.3 mg, Na 45.46 mg, K 466.35 mg, Mg 24.05 mg, Ca 46.08 mg, Mn 3.62 mg, Fe 11.62 mg, Cu 3.11 mg, Zn 5.44 mg, P 52.52 mg      |
| Mushrooms               | Morels           | <i>Morchella esculenta</i> ,<br><i>Morchella conica</i> | Not existing  |
| Nuts                    | Walnut           | <i>Juglans regia</i>                                    | Ca141 mg, K 316.9 mg, Mg 165.9 mg, Zn 2.5 mg  |
|                         | Pistachio        | <i>Pistacia vera</i>                                    |   |

## 6. Conclusions

The present study attempted to analyse historical development in relation to the nutrition transition that the Kyrgyz faced during the last 170 years. The modern Kyrgyz population's food regime was influenced by the profound transformations of the socio-economic structure, altering food culture and especially the transition of former nomads to the sedentary lifestyle. The theory of nutrition transition gives us a methodological basis to understand the change in diet patterns through a change of social transformations. Three political and economic systems that have prevailed over society put inevitable consequences on the nomads' diet and lifestyle. Annexation to the Soviet Union went hand in hand with urbanisation and thus settlement. Living

shoulder to shoulder with representatives of different ethnicities enriched the traditional food of the Kyrgyz. Simultaneously, the expansion of relations with the city and the neighbouring Russian, Uzbek, Tajik, Dungan and Uigur populations affected food types. This is especially noticeable in the Issyk-Kul region, in the Chuy Valley, in southern Kyrgyzstan. Although the food maintains its national character and its preparation methods, it has not undergone significant changes. Still, new and unfamiliar dishes appeared in it; it has become diverse. Food was enriched mainly in connection with developing new sectors of the economy, almost unknown to nomads before: horticulture, gardening, beekeeping, poultry farming.

Nutrition shifts have occurred, increasing preference to Western-type diet with political independence since 1991. Entrance of global corporations, the shift from subsistence to market economy, and trade liberalization led to the preference for readily available and easily made highly processed food. Based on the literature, we argued that the higher intake of processed food, fats, sweets, and animal products impacted the nutritional status. It has increased obesity levels among the adult population while leaving vulnerable parts of the population micronutrient deficient. Coupled with less physical activity, this diet culture impacts the population health, leading to cancer, heart diseases, diabetes, and other non-communicable diseases. The paper also explored forgotten and neglected plants, foods and drinks which are nutrient-dense and mostly grow freely in nature and are part of traditional cuisine. These locally available foods should be included in the government nutritional programs to fight current malnutrition's triple burden.

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Article

## Chapter 3. Dietary Quality of Women of Reproductive Age in Low-Income Settings: A Cross-Sectional Study in Kyrgyzstan

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**Abstract:** Dietary diversity and adequate nutrient intake are essential for conducting a healthy life. However, women in low-income settings often face difficulties in ensuring dietary quality. This research assessed relationships between dietary diversity, nutrient adequacy, and socio-economic factors among women of reproductive age (WRA) in Kyrgyzstan. A cross-sectional study was undertaken in four locations, including two rural and two urban areas in the north and south of Kyrgyzstan. A survey with pre-coded and open-ended questions was employed during the interviews of 423 WRAs aged 18–49. Data collection was conducted in March–May 2021. The average value body mass index (BMI) of WRA was  $24.2 \pm 4.6$  kg/m<sup>2</sup>. The dietary diversity score (DDS) was higher among rural women (common language effect sizes = 0.67, adjusted  $p < 0.001$ ) in the northern region (cles = 0.61,  $p < 0.05$ ) who have cropland (cles = 0.60,  $p < 0.001$ ) and a farm animal (cles = 0.60,  $p < 0.05$ ). Mean nutrient adequacy ratio (NAR) was below 1 in most micronutrients, whereas thiamine, riboflavin, vitamins B6 and C, folic acid, calcium, and magnesium were even lower than 0.5. Women with a kitchen garden or a cropland had better NAR energy (cles = 0.57), NAR carbohydrate (cles = 0.60), NAR fibre (cles = 0.60), NAR vitamin B1 (cles = 0.53), and NAR folic acid (cles = 0.54). Respondents who receive remittances and a farm animal have better NARs for energy, carbohydrates, fibre, vitamin B1, folic acid, iron, zinc, and mean adequacy ratio for 16 nutrients (MAR 16) than those who do not. Education and income have a negative correlation with dietary quality. This study contributes to the limited literature on the quality of diets in Kyrgyzstan. Hidden hunger and undernutrition are severe problems among WRA in low-income settings. Recommendations include the development of study programs in nutrition, teaching households farming practices, and raising awareness on adequate nutrition.

**Keywords:** dietary diversity; nutrient adequacy ratio; women of reproductive age; the triple burden of malnutrition



## 1. Introduction

Around three billion people in the world could not afford healthy diets in 2019 [1]. The term coined ‘triple burden of malnutrition’ refers to a situation when overnutrition, undernutrition, and micronutrient deficiency exist. It is a serious public health problem in low-income countries [2–4], including Kyrgyzstan. Micronutrient deficiency is a lack of vitamins and minerals crucial to health, and it may result from poor diet and diseases [3]. Consumption of low-nutrient and energy-rich diets may lead to obesity when vital micronutrients are still lacking in human organisms [5]. Issues of obesity are relevant not only in the developed world but also in developing countries that suffer from excessive energy intake leading to some non-communicable diseases [2].

High food prices and income inequality hinder the affordability of diversified foods [1]. Household members may experience hidden hunger regardless of their financial situation.

Hidden hunger is a silent but alarming issue affecting both disadvantaged and well-off families [6]. Still, maintaining dietary diversity is challenging for the poorest [7]. Low-income communities residing in the outskirts of urban areas are especially prone to a lack of food security [8]. They tend to have poor and monotonous diets. Dietary diversity depends on household income and energy availability [9]. Shortage of low-energy nutrition may likely occur during lean season or food shortage periods [10].

Due to low incomes, high food prices, and lack of information and knowledge, women in disadvantaged households have low-nutrient diets, which silently lead to hidden hunger. Food diversity is essential for adequate nutrition and health. The intake of diversified foods is often advised to prevent the body from lacking important micronutrients, vitamins, and minerals. Nutritious food refers to the sufficient intake of calories and quality food (variety and micronutrient value of food). However, although food security is a prerequisite for nutrition security, it is not enough for ensuring the sufficiency of maintaining good nutritional status [11]. Consuming a variety of foods from different food groups is the underlying method for achieving and preserving nutrient adequacy [12].

Women in low-income settings are especially vulnerable to undernutrition. The intake of three minerals—iron, iodine, and calcium—is vital for a woman of reproductive age. Proper nutrition of women, especially during pregnancy, is vital for her and her future offspring’s brain and neurodevelopment [13]. Iodine is vital for brain development. Adequate intake of iodine in pregnancy is important, as in-utero deficiency may have lifelong consequences for the offspring [14]. The WHO iodine recommendation for pregnant women is 250 µg/d (in comparison to the German Nutrition Society’s (DGE) recommendation for pregnant and breastfeeding women, which is 200 µg/d), which is higher than the 150 µg/d recommendation for adults. Adequate nutrition, including the intake of diversified foods, supports the organism by fulfilling important macro and micro-elements. Vitamins and minerals have diverse important biochemical functions in the cellular processes of human

organisms. For example, vitamin A acts as a regulator of cell and tissue growth and differentiation. Vitamin D is essential for bones and other organs as it regulates mineral metabolism. Important in reproductive age, vitamins C and E act as antioxidants, a substance that neutralizes a free radical, thereby preventing oxidative injury to cells and tissues [15,16].

Iron is an essential part of haemoglobin for oxygen transport and of myoglobin for transporting and storing oxygen in the muscle and releasing it when needed during muscle contraction [17]. The recommended dietary allowance (RDA) value for Fe is 15 mg and 30 mg for pregnant women [18]. Calcium is vital for the development of bone, teeth, and muscles and is associated with vitamin D metabolism as well [17]. The RDA for Ca is 1000 mg (DGE, 2021). Selenium has antioxidant and anti-inflammatory properties [19]. This article explores 16 macro-and micronutrients, but the above-mentioned micronutrients are also vital for women of reproductive age.

## Literature Review on Nutrition in Kyrgyzstan

Kyrgyzstan is a lower-middle-income country [20], where nutrition-related issues exist that impede overall human development. Changing lifestyles coupled with low physical activity and consumption of processed foods and beverages in developing countries causes issues such as becoming overweight [21]. The nutrition transition is taking place in the Kyrgyz society as well. Around 10–15 years ago, Kyrgyzstan's population had higher undernutrition and lowered overnutrition levels among European and Central Asian countries [22]. However, this picture is changing as becoming overweight becomes a severe problem for many people in the country. Additionally, 80% of deaths in 2019 were due to non-communicable diseases (NCDs) [23]. An analysis of the diseases model shows that infectious diseases have been decreasing for the last 30 years, whereas the proportion of people with non-communicable illnesses (NCDs) has been increasing [24].

The National Food Security and Nutrition Program, approved by the government of the Kyrgyz Republic Decree Nr. 618 dated 4 September 2015, points out, among others, the importance of a balanced diet in addressing micronutrient deficiency. Irrespective of this program, maternal health requires special attention in Kyrgyzstan. Despite healthcare reforms, maternal mortality remains high [25]. For the period of 1990–2015, it reduced only by 7%. In Kyrgyzstan, a high percentage of anaemia, iodine deficiency, and diabetes among pregnant women is common [26]. The prevalence of anaemia among pregnant women was 39.8% in 2016 [27], whereas most of the anaemia among WRA was 36.2% in 2016 [28]. The prevalence of overweight among women was 48.8% in 2016, and the prevalence of obesity among women constituted 18.6%. These indicators steadily increased since 1975 (27.1% and 5.6%, respectively, in 1975) [29].

The nutritional status of women is of special concern. Nationally, over half of the women have a normal body mass index (BMI) (57%), while 7% are undernourished or thin (BMI less than 18.5), and 36% are overweight or obese (BMI 25 or higher) in the country. The mean BMI for women aged 15–49 is 24.1, which falls

in the standard BMI classification. Differences in BMI levels by background characteristics are apparent. Women aged 15–19 are more likely than women in other age groups to be thin or underweight (18% versus 2–8%). In contrast, the proportion of overweight women increases with age; among women aged 40–49, 41% are overweight, and 31% are obese. Rural women are more likely to be overweight or obese than urban women (38 and 32%, respectively). By region, the proportion of undernourished women does not vary much; however, the ratio of overweight women ranges from 19% in Bishkek to 30% in the Naryn region. Obesity is more common among women from the Issyk-Kul, Osh Oblast, Talas, and Chui regions (14–16%) than among women from other areas (8–10%). Women with primary general education are more likely to be thin and less likely to be overweight or obese than women with more education. Similarly, women in the highest wealth quintile are slightly more likely to be thin and less likely to be overweight or obese than women from less affluent households. Among women, anaemia, iron deficiency, and lack of vitamin A are widespread micronutrient deficiencies in Kyrgyzstan [30].

Improving dietary diversity is a strategy that can be employed on a micro-level. Its assessment can be performed through calculating the number of different food groups consumed over a specific reference period [31]. On a global scale, literature on dietary diversity in Africa [10,32–37] is abundant. DD studies in South-East Asia [38,39] and India [40,41] enrich the literature on this topic as well. These works consider different socio-economic factors, including farm production and market access together with other determinants, and their exciting insights are related to the dietary diversity of women, children, and households. Staples are the commonly consumed food group in all these areas. Legumes, green leaves, vegetables, fish, and roots and tubers seem to be widely consumed in Africa. Meat and poultry are less commonly consumed food groups in some African countries.

The nutrition topic is understudied in the Central Asian region. Existing literature on maternal nutrition in Kyrgyzstan, among other things, is insufficient [25]. Some nutritional indicators made substantial improvements. For the period 1997–2004, child stunting prevalence reduced nationally from 36% to 13%. Although, on the province level, the decline rates have some differences [42,43]. Despite these advancements, maternal nutritional status did not make rapid improvements. This issue requires further research and policy analysis [42].

Different methodologies for measuring food diversity exist in the literature. Some indexes are based on the quantitative distribution of consumed foods as a measurement for diet diversity [44]. Some of the main measurements are dietary diversity score (DDS), food variety score (FVS) [10], Household Dietary Diversity Score (HDDS) [45], and Minimum Dietary Diversity for Women of Reproductive Age (MDD-W) [46]. FVS, DDS, DDS half, and dietary serving score were employed by [47] as a method to assess dietary diversity among the elderly in Sri Lanka. Dietary diversity indicators group foods together when they are considered nutritionally similar and/or play the same role in the diet [31]. While developing the MDD-W, many different candidate indicators, with different numbers of food groups and different food group definitions, were considered. The indicator based on the ten groups described further in the methods part had a stronger relationship to micronutrient

adequacy than other candidate indicators with different groupings [48]. Thus, this paper employs MDD-W (further referred to as DDS).

The study objectives are (1) to understand how diversified the diet of women 18–49 years old in Kyrgyzstan is and their similarities and differences in urban and rural areas; (2) to find out determining factors impacting dietary quality (DDS and nutrient adequacy) among women; (3) additionally, we intend to understand whether DDS can be a proxy for micronutrient deficiency in the context of WRA from low-income families of Kyrgyzstan.

This article intends to make the following contributions to the literature. Firstly, dietary quality assessment is performed on two bases: evaluation of dietary diversity and nutrient adequacy ratio and mean adequacy ratio. Most works rely on the simple count of food groups. DDS alone is not a proxy for measuring food security. Ensuring that individuals or households have nutrient adequacy requires more data for analysis. Most articles that study DD do not consider nutritional outcomes [32,34,38,41]. A simple count of food groups does not completely picture nutrient sufficiency [33]. High DD does not always translate into the absence of micronutrient deficiency. Therefore, our study intends to fill the existing gap in the literature and employs nutrient adequacy ratio and mean nutrient adequacy ratio to better picture the diet quality of women in Kyrgyzstan.

Second, dietary diversity is believed to be a plausible indicator for assessing micronutrient deficiency, although it has its peculiarities [49]. Determination of micronutrient adequacy is expensive if one analyzes it through blood [49]. In our article, we calculated micronutrient deficiency for each respondent separately. We believe this approach gives us more accuracy in understanding hidden hunger among women of reproductive age. Third, understanding how households with limited resources nurture themselves and comprehending their diet composition will give insights to policymakers to improve current nutrition strategies and programs. To the best of our knowledge, dietary quality assessment using a scientific approach has not been performed in Kyrgyzstan yet.

Based on the existing literature, our hypothesis states that, as the society in Kyrgyzstan undergoes nutrition transition, women suffer from overnutrition, undernutrition, and micronutrient deficiency in low-income settings. Due to the poor dietary diversity, women are short of vital micronutrients. Socio-economic, demographic, markets, and farms are the determining factors impacting WRA's diet quality.

## 2. Materials and Methods

The study has a community-based cross-sectional survey design, and data were collected from women of the 18–49 age group ( $n = 423$ ) between March and May 2021. Random and snowball sampling was followed in the selection of women in Kyrgyzstan. Respondents were selected in the two biggest cities of Kyrgyzstan: Bishkek ( $n = 99$ ) and Osh ( $n = 98$ ), as well as two rural areas of At Bashy ( $n = 90$ ) and Aravan ( $n = 136$ ) districts. The survey included women residing in disadvantaged neighbourhoods, including family dormitories and slums near big markets (Dordoi,

Osh bazar). Pregnant, lactating women and those from well-off families were excluded from the survey.

The survey was based on pre-coded and open-ended questions. Methods include (1) descriptive statistics of cross-sectional data; (2) analysis of demographic and socioeconomic variables with DDS (dietary diversity score) , NAR (nutrient adequacy ratio), and MAR (mean adequacy ratio) for 16 nutrients, which are energy, protein, carbohydrates, fat, fibre, vitamin A, vitamin C, vitamin E, vitamin B6, folic acid, iron, zinc, magnesium, calcium, riboflavin, and thiamine.

## 2.1. Study Area

The field research was conducted in different cultural, geographical, agro-ecological, and historical locations (Table 8). Two urban areas, Bishkek (capital) and Osh (the second largest city), and two rural areas (At Bashy and Aravan districts) were the study locations. The At-Bashy district of Naryn oblast is situated on both banks of the Naryn River (one of the central headwaters of the Syrdarya) [50]. It is a mountainous region whose economy depends predominantly on animal husbandry. It is located at 2044 m above sea level and consists of 98% of ethnic Kyrgyz.

Table 8. Study area information

| <b>Region</b>                   | <b>North</b> |          | <b>South</b> |          |
|---------------------------------|--------------|----------|--------------|----------|
| <b>Location</b>                 | Bishkek      | At Bashy | Osh          | Aravan   |
| <b>Urban/rural</b>              | Urban        | Rural    | Urban        | Rural    |
| <b>N of respondents</b>         | 99           | 90       | 98           | 136      |
| <b>Geographical coordinates</b> | 42.87' N     | 41.16' N | 40.52' N     | 40.51' N |
|                                 | 74.59' E     | 75.80' E | 72.79' E     | 72.49' E |

The Aravan district Osh oblast is located in one of the world's most populous places, Fergana Valley (Figure 13). It is an ethnically mixed location comprising Uzbeks, Kyrgyz, Russians, Tajiks, and others near Uzbekistan's border. It is at 963 m above sea level. Agriculture is a historically significant part here, including planting cotton, fruits and vegetables, nuts, and many other crops later sold in cities.



Figure 13. Map of Kyrgyzstan with an indication of field locations [51]

## 2.2. Questionnaire

The survey included modules on socioeconomics, demographics, farm, market, and 24-hour diet recall (Figure 14) and was administered by female trained encoders. Determinants of nutrition include distance to the market, household income, and household production [4]. Some studies found that cropland and kitchen gardens positively impact dietary diversity scores [40]. Therefore, we added these variables to our questionnaire.

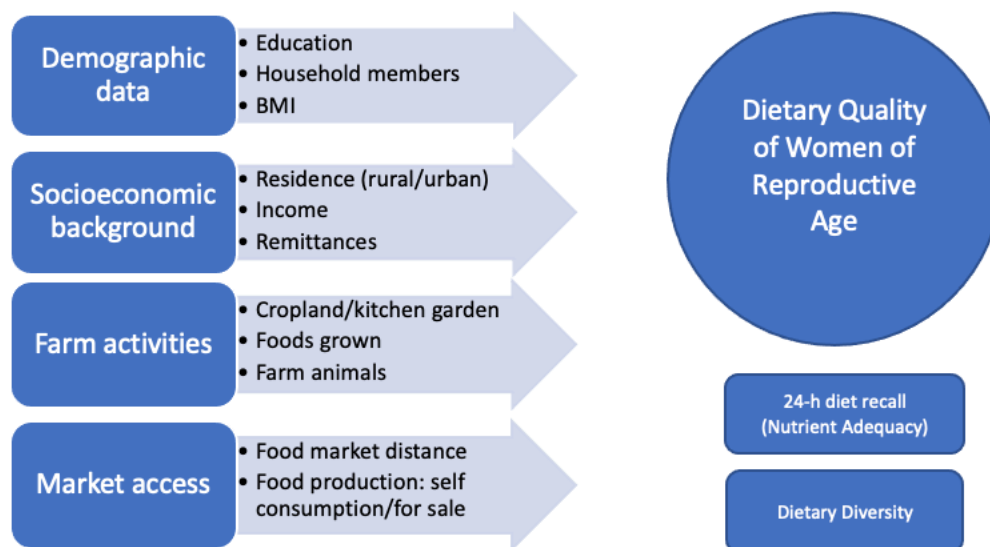


Figure 14. Determining factors impacting the dietary quality of WRA (Source: authors' visualization)

Interviews were conducted in official languages of the Kyrgyz Republic, which are Kyrgyz and Russian. The interview data were collected with the online tool Typeform [52], transferred to the descriptive Excel datasheet, and then transferred to the quantitative statistical analysis and programming language R. A 24-hour diet recall was conducted based on 16 food groups and was then grouped into ten food groups developed by FAO [46] to assess dietary diversity. Additionally, the calculation of macro-and micronutrients was performed with the software Nutrisurvey (EBISpro: Willstätt, Germany, 2007) [53]. Finally, the draft questionnaire was piloted with 25 people. After the comments of test respondents, changes to the questionnaire were made, such as rephrasing the questions, changing to local names, and adding more local foods.

### 2.3. Anthropometric Measurements

Enumerators were trained by the medical personnel to perform anthropometric measurements. Each respondent was weighed (in kg) by the mobile scale and measured by the mobile stadiometer (in cm). BMI is an indirect measure of body fat through height and weight, and it is calculated by kg/m<sup>2</sup>. Four categories of BMI exist—underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), and obese (above 30) [29].

### 2.4. Nutrient Adequacy Ratio

For the investigation of the dietary quality of WRAs, two methods were used in this study. Firstly, a 24-hour diet recall was based on the internationally accepted methodology for assessing women’s macro-and micronutrient deficiency. We recorded all foods, including dishes, together with exact ingredients and portion sizes for precise calculation for portions that were consumed for breakfast, lunch, dinner, and snacks in between. The entry of ethnic dishes’ recipes into the software was according to the book “Kyrgyz Modern Cuisine”[54].

The nutrient adequacy ratio (NAR) is calculated for each nutrient by using Equation (1).

$$\text{NAR} = \frac{\text{Actual intake}}{\text{Recommended daily intake}} \quad (1)$$

$$\text{MAR} = \frac{\text{Sum of NAR}}{\text{Number of nutrients}} \quad (2)$$

Due to the lack of recommendation for dietary intake (RDI) developed for women in Kyrgyzstan, we employed the RDI used by Russia and Germany. The mean nutrient adequacy ratio (MAR) is calculated for 16 macro-and micronutrients using the equation (2). When NAR = 1 and MAR = 1, it indicates that nutrient intakes have met the RDI. NAR and MAR > or < 1 means lack or overconsumption of specific micronutrients [55].

## 2.5. Dietary Diversity Score

DDS consists of ten main following food groups:

1. Grains, white roots and tubers, and plantains;
2. Pulses (beans, peas and lentils);
3. Nuts and seeds;
4. Milk and milk products;
5. Meat, poultry, and fish;
6. Eggs;
7. Dark green leafy vegetables;
8. Other vitamin A-rich fruits and vegetables;
9. Other vegetables;
10. Other fruits.

Women who consumed less than five items out of the ten food groups were more likely to be micronutrient poor. Those who had more than five items out of the ten food groups were less likely to be micronutrient poor [46]. We asked which ingredients were used and registered all different elements included in the meal (whenever the quantity was > 15 g per serving). On the spot, we recorded per meal which foods and portions had been consumed by ticking the related food group from, for example, the list of 16 different food groups shown in the questionnaire and used 10 groups in this paper [46]. Pictures of a plate, a teacup, a soup cup, a tablespoon, and a teaspoon were employed for the identification of portions.

## 2.6. Data Analysis

Statistical analysis was conducted using the R language for statistical computing [56] and RStudio [57]. Illustrations were built with Excel. Continuous variables were presented with their respective mean, standard deviation (SD), standard error (SE), median, and first (Q1) and third (Q3) quartiles. Medians were calculated, and averages were shown. Categorical variables were presented with proportions and percentages. Comparisons were carried out using Mann–Whitney U tests for continuous variables. The threshold used for statistical significance was  $p < 0.05$ .

Effect sizes were reported as common language effect size (using package “canprot” [58], pseudo-median, and its nonparametric 95% confidence interval (CI).

Correlations were assessed using Kendall’s tau. The Benjamini–Hochberg method was used to control the false discovery rate [59].



### 3. Results

#### 3.1. Socio-Economic Characteristics of WRAs

The socio-economic characteristics of respondents are summarized in Table 9. The sample size involved 423 WRA, 226 women from rural areas and 197 women from urban areas, with an age range of 18–49. Around two-thirds of respondents ( $n = 287$ ) were Kyrgyz, and 136 were representatives of other ethnic groups such as Dungans, Koreans, Russians, Tajiks, Uigurs, and Uzbeks. Most of the respondents ( $n = 170$ ) were literate, having secondary school diplomas and higher education certificates ( $n = 167$ ). Of the respondents, 73% of the women were married, and 64% lived with at least one child under 18 in one household. Most households (59.6%) were considered as large families consisting of more than four members, predominantly residing in rural areas (75.7%). More than half of the women's main income source was employment. Agriculture was the second main income source for almost 17% of respondents, out of which the majority resided in rural areas. An important difference between women in rural and urban areas is that most of the women's source of income in rural areas originates in agricultural activities (28%) than in urban areas (3%). Remittances are vital for around 18% of rural and 22% of urban women. More than a third of respondents' household income was (41.8%) 0–10,000 Kyrgyz soms, which is roughly 0-\$115 US.

Table 9. Socioeconomic characteristics of respondents ( $n = 423$ )

| Characteristic                | Rural n (%) | Urban n (%) | Total Value n (%) |
|-------------------------------|-------------|-------------|-------------------|
| Age (years):                  |             |             |                   |
| 18–27                         | 50 (22.1%)  | 77 (39%)    | 127 (30.0%)       |
| 28–39                         | 96 (42.5%)  | 66 (33.5%)  | 162 (38.3%)       |
| 40–49                         | 80 (35.4%)  | 54 (27.4%)  | 134 (31.7%)       |
| Ethnicity:                    |             |             |                   |
| Kyrgyz                        | 105 (46.5%) | 182 (92.3%) | 287 (67.7%)       |
| Non-Kyrgyz                    | 121 (53.5%) | 15 (7.6%)   | 136 (32.3%)       |
| Education:                    |             |             |                   |
| Primary Education             | 35 (15.5%)  | 8 (4%)      | 43 (10.2%)        |
| Secondary Education           | 104 (46%)   | 66 (33.5%)  | 170 (40.2%)       |
| Vocational School             | 25 (11%)    | 16 (8.1%)   | 41 (9.7%)         |
| Higher Education              | 60 (26.5%)  | 107 (54.3%) | 167 (39.5%)       |
| Marital status:               |             |             |                   |
| Single                        | 29 (12.8%)  | 66 (33.5%)  | 95 (22.5%)        |
| Married                       | 189 (83.6%) | 120 (60.9%) | 309 (73.0%)       |
| Divorced                      | 8 (3.5%)    | 11 (5.6%)   | 19 (4.5%)         |
| Household Income (KG soms) *: |             |             |                   |
| 0–5000                        | 32 (14.2%)  | 21 (10.6%)  | 53 (12.5%)        |
| 5000–10,000                   | 82 (36.3%)  | 42 (21.3%)  | 124 (29.3%)       |
| 10,001–20,000                 | 67 (29.6%)  | 66 (33.5%)  | 133 (31.4%)       |
| 20,001–30,000                 | 29 (12.8%)  | 55 (27.9%)  | 84 (19.9%)        |
| 30,001–40,000                 | 10 (4.4%)   | 10 (5%)     | 20 (4.7%)         |
| 40,000 and More               | 6 (2.7%)    | 3 (1.5%)    | 9 (2.1%)          |

|                                 |               |               |               |
|---------------------------------|---------------|---------------|---------------|
| Family Size:                    |               |               |               |
| 4 or Less                       | 55 (24.3%)    | 116 (58.9%)   | 171 (40.4%)   |
| More than 4                     | 171 (75.7%)   | 81 (41.1%)    | 252 (59.6%)   |
| Receive remittances:            |               |               |               |
| Yes                             | 67 (29.6%)    | 26 (13.2%)    | 93 (22.0%)    |
| No                              | 159 (70.4%)   | 171 (86.8%)   | 330 (78.0%)   |
| BMI level (kg/m <sup>2</sup> ): |               |               |               |
| Underweight                     | 13 (5.7%)     | 19 (9.6%)     | 32 (7.6%)     |
| Normal Weight                   | 118 (52.2%)   | 118 (59.9%)   | 236 (55.8%)   |
| Overweight                      | 59 (26.1%)    | 44 (22.3%)    | 103 (24.3%)   |
| Obese                           | 36 (15.9%)    | 16 (8.1%)     | 52 (12.3%)    |
| Mean (±SD)                      | 24.82 (±4.47) | 23.52 (±4.82) | 24.21 (±4.68) |
| Children:                       |               |               |               |
| Yes                             | 175 (77.4%)   | 98 (49.7%)    | 273 (64.5%)   |
| No                              | 51 (22.6%)    | 99 (50.3%)    | 150 (35.5%)   |
| Source of income:               |               |               |               |
| Employment                      | 97 (42.9%)    | 155 (78.7%)   | 252 (59.6%)   |
| Agriculture                     | 65 (29%)      | 6 (3%)        | 71 (16.8%)    |
| Remittances                     | 41 (18.1%)    | 22 (11.2%)    | 63 (14.9%)    |
| Private Business                | 17 (7.5%)     | 10 (5%)       | 27 (6.4%)     |
| Government Support              | 6 (2.6%)      | 4 (2%)        | 10 (2.4%)     |

\* KG soms is the local currency, 1 USD = 84.8 KG soms; BMI stands for body mass index; Underweight (below 18.5), normal weight (18.5–24.9), overweight (25.0–29.9), obese (30.0 and above).

### 3.2. Nutritional Status

The mean height and weight of women in our sample were 161 cm (±6.6 cm) and 63 kg (±12.6 kg), respectively. The mean BMI of respondents was 24.2 ± 4.6 kg/m<sup>2</sup>, close to the threshold of 25.0. Although 58.8% of women had a normal BMI, more than one-third of survey participants were overweight or obese (36.6%), and undernutrition was among 7.6% of participants.

### 3.3. Individual Food Consumption and Diet Diversity Score

Almost all women reported consumption of starchy staples (Figure 15). The second most consumed food group was meat, offals, and processed meat products. Consumption of fish and fish products was minimal. Vitamin A-rich vegetables and fruits followed as the third most eaten food group among women in Kyrgyzstan. Traditional cuisine consisted of different dishes, which predominantly included staples, meat, and vitamin A-rich vegetables. Widely consumed were *besht barmak* (noodle, meat, onion), *plov* (rice, meat, carrots, onion), *lagman* (noodles, meat, carrot, red pepper, and other vegetables), *manty* and *oromo* (noodle, meat, onion, pumpkin/potato), *grechka* (buckwheat, meat, carrots), *pelmeni* (noodles, potato, meat, onion), *pirojki* (dough, potato, onion), *kesme* (noodles, meat, onion, carrots), and *mastava* (rice, meat, onion, carrot). Milk and milk products were the fourth most important in the diet of women in Kyrgyzstan. Almost 77% of rural women reported consuming dairy products in the last 24 hours when the survey was conducted. Nuts

and seeds, beans and peas, and eggs were consumed moderately, constituting more than 30% of rural women and much less among women in the cities (14.72%, 14.21% and 26.4%, respectively). Pea soups were consumed by some respondents, whereas nuts and seeds were mostly as additions to salads, sweets, and dishes. Fried eggs were favoured due to their quick preparation. Vitamin A-rich dark green leafy vegetables were eaten by a very small number of women comprising around 30% in both locations, although dill, coriander, parsley, green garlic, and chives usually grow in the spring period when data collection was conducted (Figure 15).

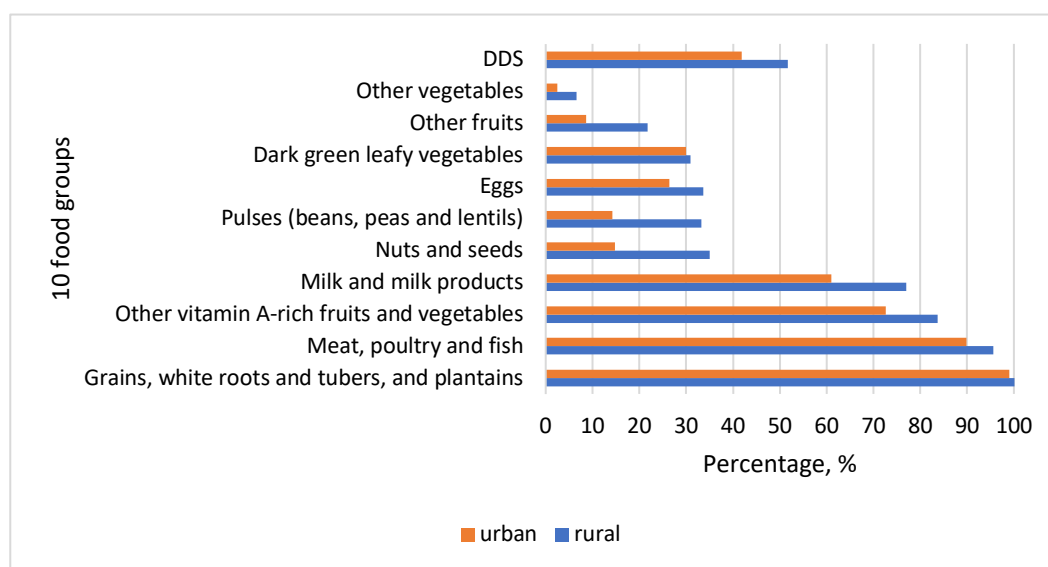


Figure 15. Consumption of ten food groups among women of reproductive age (WRA), and dietary diversity score (DDS) in rural and urban areas

Generally, fruits and vegetables were consumed by a few women, 21.68% and 6.64% in rural areas and 8.63% and 2.54% in cities, respectively. Seasonal availability of fruits and their high prices off-season might hinder women from low-income families to afford them. There is a general trend in all food groups that their consumption was higher among rural women than in urban areas. However, DDS is still quite close to the threshold 5, meaning that there is little difference between women in two different geographical settings. Relatively low mean DDS in both areas may likely be because the data collection took place during the lean season when food availability was low, and their prices were high.

The division into food groups is an internationally recognized method. This study used the updated recommendations developed by FAO (2021), including ten food groups (Table 10). Locally consumed foods included both traditional Kyrgyz as well as those that originated in other cultures. Due to past migration processes, local cuisine was influenced by the diet of ethnic groups such as Koreans, Dungans, Uigurs, Russians, Uzbeks, and others. Besides noodles and rice, starch staples include buckwheat, barley, potatoes, and others. Meat foods include those indicated in Table 3.3. and very little fish. Due to the past nomadic food culture and current semi-nomadic lifestyle in some rural areas, dairies are an essential cuisine element. Among others, these foods include homemade ones such as *kurut* (dried concentrated ayran),

*suzmo* (concentrated yogurt), *kajmak* (creamy milk residue), *ayran* (sour milk), *sary maj* (ghee), *kymyz* (fermented mare's milk), and many others.

Table 10. Food groups and locally consumed foods obtained from 24-hour diet recall

| Food Groups                                   | Reported and Locally Consumed Foods  |
|---|--|
| Grains, white roots and tubers, and plantains | Wheat, rice, buckwheat, pearl barley, wheat bread, pasta products, potato, oatmeal, radish   |
| Meat, poultry and fish                        | Beef, mutton, goat, chicken, sausage products ( <i>sosiska</i> , <i>kolbasa</i> ), smoked sausage, horse sausage ( <i>chuchuk</i> ), liver, stomach, intestine, canned fish  |
| Other Vitamin A-rich fruits and vegetables    | Carrot, sweet red pepper, pumpkin, apricot, dried apricot, peach, persimmon, melon   |
| Milk and milk products                        | Cow milk, <i>ayran</i> , kefir, dried <i>suzmo</i> ( <i>kurut</i> ), concentrated <i>ayran</i> ( <i>suzmo</i> ), cream ( <i>kajmak</i> , <i>smetana</i> ), ghee ( <i>sary maj</i> ), fermented mare's milk ( <i>kymyz</i> ), quark ( <i>tvorog</i> ), cheese |
| Nuts and seeds                                | Walnuts, peanuts, pistachios, sunflower seeds  |
| Pulses (Beans, peas and lentils)              | Red beans, chickpeas, mung beans, lentils  |
| Eggs  | Chicken eggs   |
| Dark green leafy vegetables                   | Dill, coriander, parsley, green garlic, green onion, grape leaves, rhubarb, chives   |
| Other fruits                                  | Apple, banana, dried fruits, oranges, cherries, quince, pomegranate, prune, raspberries, sandthorn, currant berries  |
| Other vegetables                              | Cabbage, garlic, cucumber, tomato, onion, eggplant, beetroot   |

In parenthesis, Kyrgyz names are indicated.

Consumption of animal-based proteins is typical. Meat, organ meat, and milk products belong to one of the most consumed food groups. Nearly 40% of households possessed at least one farm animal, primarily cows, sheep, goats, chickens, or horses. Almost 50% of respondents owned a kitchen garden or cropland where they grew numerous crops, fruits, and vegetables. In mountainous areas such as At Bashy, mostly potatoes, barley, beet, and garlic are grown. At a lower altitude valley area in Aravan, a variety of plant foods is broad, including cucumber, tomato, radish, green onion, red pepper, eggplant, cabbage, chives, dill, strawberry, persimmon, grape, fig, peach, pomegranates, cherry, apricot, apple, rice, corn, pistachios, and lemon.

### 3.4. Nutrient Intake and Diet Quality

Currently, Kyrgyzstan lacks a state-confirmed recommended daily intake (RDI) for women between 18 and 49. Therefore, we used RDI from the State Sanitary and Epidemiological Regulation of the Russian Federation (2009) and the DGE German Nutrition Society (2021) in this study. Both RDIs have slight differences, for example, RDI for protein by the Russian RDI is 65 g, whereas the DGE recommendation is based on weight 0.8 to 1 g/kg. Most norms for vitamins and minerals in the Russian RDI are higher than in the German one (Table 11).

Table 11. Nutrient intake and its adequacy measured by 24-hour diet recall (n = 423).

| Nutrient          | Rural (n = 226)    |               |            | Urban (n = 197)     |               |            | Total Group         |               |            | RDI        |       |
|-------------------|--------------------|---------------|------------|---------------------|---------------|------------|---------------------|---------------|------------|------------|-------|
|                   | Mean ± SD          | NAR<br>Russia | NAR<br>DGE | Mean ± SD           | NAR<br>Russia | NAR<br>DGE | Mean ±<br>SD        | NAR<br>Russia | NAR<br>DGE | Russi<br>a | DGE   |
| Energy (kcal)     | 1731.42<br>± 569.4 | 0.81          | 0.79       | 1551.58<br>± 611.26 | 0.72          | 0.71       | 1647.66<br>± 595.36 | 0.77          | 0.75       | 2150       | 2200  |
| Protein (g)       | 58.14<br>± 21.51   | 0.89          | 1.12       | 61.51<br>± 30.00    | 0.95          | 1.25       | 59.71<br>± 25.84    | 0.92          | 1.18       | 65         | 50.70 |
| Fat (g)           | 61.98<br>± 31.98   | 0.86          | 0.85       | 59.68<br>± 30.89    | 0.83          | 0.81       | 60.91<br>± 31.46    | 0.85          | 0.83       | 72         | 73.3  |
| Carbohydrates (g) | 231.57<br>± 89.99  | 0.74          | 0.84       | 188.67<br>± 86.41   | 0.61          | 0.69       | 211.59<br>± 90.80   | 0.68          | 0.77       | 311        | 275   |
| Fibre (g)         | 17.99<br>± 7.04    | 0.90          | 0.60       | 14.90<br>± 6.91     | 0.74          | 0.50       | 16.55<br>± 7.14     | 0.83          | 0.55       | 20         | 30    |
| Vitamin A (µg)    | 910.09<br>± 997.47 | 1.01          | 1.30       | 820.24<br>± 665.65  | 0.91          | 1.17       | 868.24<br>± 859.24  | 0.96          | 1.24       | 900        | 700   |
| Vitamin E. (mg)   | 11.20<br>± 8.02    | 0.75          | 0.93       | 12.34<br>± 8.94     | 0.82          | 1.03       | 11.73<br>± 8.47     | 0.78          | 0.98       | 15         | 12    |
| Vitamin B1 (mg)   | 0.62 ± 0.28        | 0.41          | 0.62       | 0.59<br>± 0.35      | 0.39          | 0.59       | 0.60<br>± 0.31      | 0.40          | 0.60       | 1.5        | 1     |
| Vitamin B2 (mg)   | 0.78 ± 0.33        | 0.43          | 0.71       | 0.77<br>± 0.33      | 0.43          | 0.70       | 0.77<br>± 0.33      | 0.43          | 0.70       | 1.8        | 1.1   |
| Vitamin B6 (mg)   | 0.92<br>± 0.36     | 0.46          | 0.66       | 0.93<br>± 0.43      | 0.46          | 0.66       | 0.92<br>± 0.39      | 0.46          | 0.66       | 2          | 1.4   |
| Fol. acid (µg)    | 165.2<br>± 74.17   | 0.41          | 0.55       | 145.75<br>± 79.53   | 0.36          | 0.49       | 156.14<br>± 77.24   | 0.39          | 0.52       | 400        | 300   |
| Vitamin C (mg)    | 42.01<br>± 36.84   | 0.47          | 0.44       | 44.52<br>± 45.98    | 0.49          | 0.47       | 43.18<br>± 41.31    | 0.48          | 0.45       | 90         | 95    |
| Calcium (mg)      | 323.16<br>± 161.04 | 0.32          | 0.32       | 286.13<br>± 132.01  | 0.29          | 0.29       | 305.92<br>± 149.21  | 0.31          | 0.31       | 1000       | 1000  |
| Magnesium (mg)    | 198.82<br>± 72.59  | 0.50          | 0.65       | 185.24<br>± 82.05   | 0.46          | 0.61       | 192.50<br>± 77.35   | 0.48          | 0.63       | 400        | 305   |
| Iron (mg)         | 10.08<br>± 3.61    | 0.56          | 0.67       | 9.93<br>± 4.42      | 0.55          | 0.66       | 10.01<br>± 4.00     | 0.56          | 0.67       | 18         | 15    |
| Zinc (mg)         | 9.25<br>± 3.75     | 0.77          | 1.16       | 10.19<br>± 5.34     | 0.85          | 1.27       | 9.69<br>± 4.58      | 0.81          | 1.21       | 12         | 8     |

RDI stands for recommended daily intake; NAR stands for nutrient adequacy ratio; SD is standard deviation; DGE stands for Deutsche Gesellschaft für Ernährung e.V., the German Nutrition Society.

Diet analysis was performed to derive nutrient intakes of respondents. Total mean energy intake was 1647 kcal, whereas protein, fat, carbohydrates, and fibre were around 59 g, 61 g, 211 g, and 16 g, respectively. These indicators are lower than the Russian RDI. According to the recommendations by the DGE, some mean NAR indicators show around 1, meaning that respondents have adequate nutrient intake daily. These nutrients include protein, vitamin A, E, and zinc, but, according to the Russian RDI, all macro-and micronutrients are either below or close to 1.

Regardless of these norm differences between these two countries, mean NAR is below 1 in most macro-and micronutrients when calculated with RDIs, some of

them being even lower than 0.5. These are the critical micronutrients such as vitamins B1, B2, B6, and C and folic acid, calcium, and magnesium. These results indicate that hidden hunger exists, and undernutrition is a severe problem among WRA in low-income settings in Kyrgyzstan.

### Analysis of Dietary Diversity Concerning Some Socio-Economic and Farm Variables

We employed Mann-Whitney U tests to carry out group comparisons for continuous variables. Namely, we performed comparisons for DDS with socio-economic and demographic variables (Table S2 in Supplementary Material). We found that differences exist in residence, region, kitchen garden or cropland, and farm animals in terms of dietary diversity (Figure 16). When a respondent in the rural group was compared to the respondent in the urban group, the respondent from the urban group had higher DDS than the respondent in the rural group in only 33% of cases. This means that in 67% of cases, DDS was higher among rural WRAs than in urban. In 61% of cases, DDS in the north was higher than in the south. In 39% of cases, DDS in the south was more than in the north. This is an interesting result because the south is traditionally more favorable for growing fruits, vegetables, pistachios, and almonds due to its warm climatic conditions. Considering these results, knowledge on nutrition, significance of dietary diversity, food storage, and gardening should be improved in the southern region.

In 59.9% of cases, DDS among women with a kitchen garden or cropland was higher than women without a kitchen garden or cropland. Women who have a least one farm animal also had better DDS in almost 60% of cases. These results indicate that women have more diversified diets in rural areas, in the northern region, and those who have cropland or a kitchen garden and at least one farm animal in comparison to those who live in cities in the south and do not possess a piece of land and a farm animal.

### 3.5. Nutrient Adequacy Ratio and its Socio-Economic Factors

We employed Kendall tau to analyze the correlation between NAR for 16 nutrients with income, education, and BMI. During our analysis, we discovered that a correlation between income and some NARs existed. Namely, there is a very weak negative statistically significant correlation between income and NAR for carbohydrates, fibre, vitamin B1, folic acid, and magnesium (Figure 17). This indicates that the more households earn, the less of these micronutrients' women obtain from their diets. However, when corrected for multiple testing, the statistical significance for carbohydrates, vitamin B1, and magnesium was no longer observed.

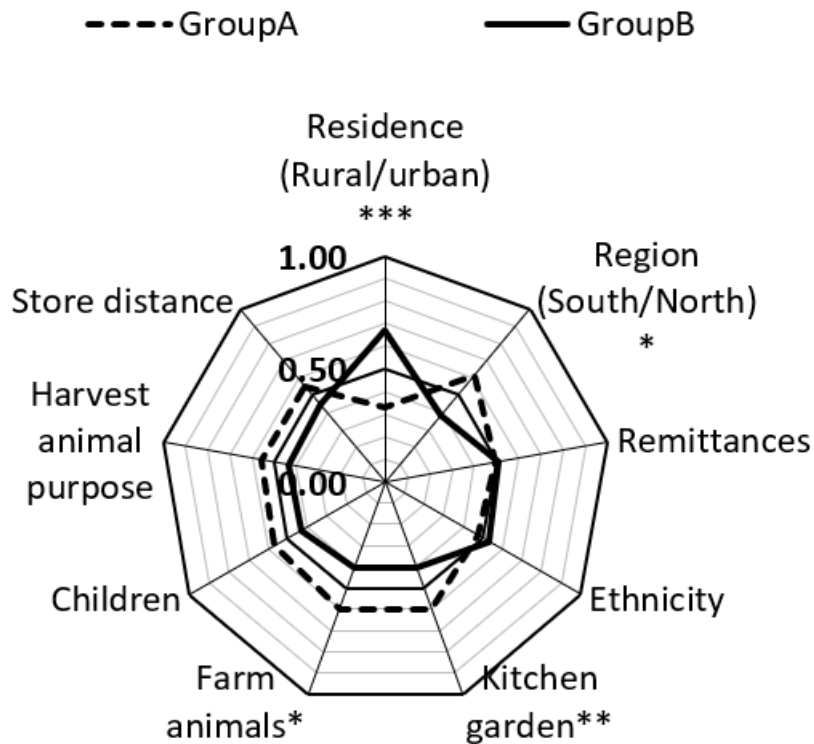


Figure 16. Determining factors for dietary diversity

The figure shows CLES-common language effect size in two groups. **Group A** includes urban residents; -northern region; remittances; non-Kyrgyz ethnicity; kitchen garden, farm animals, children; harvest animal purpose is to mostly self-consume; store distance more than 2 km. **Group B** includes rural residents, southern region; no remittances; Kyrgyz ethnicity, no kitchen garden, farm animals, or children; harvest animal purpose is mostly to sell; store distance-2 km or less. \* p-value < 0.05; \*\* p-value < 0.01; \*\*\* adjusted p-value is < 0.001 (The Benjamini-Hochberg method)

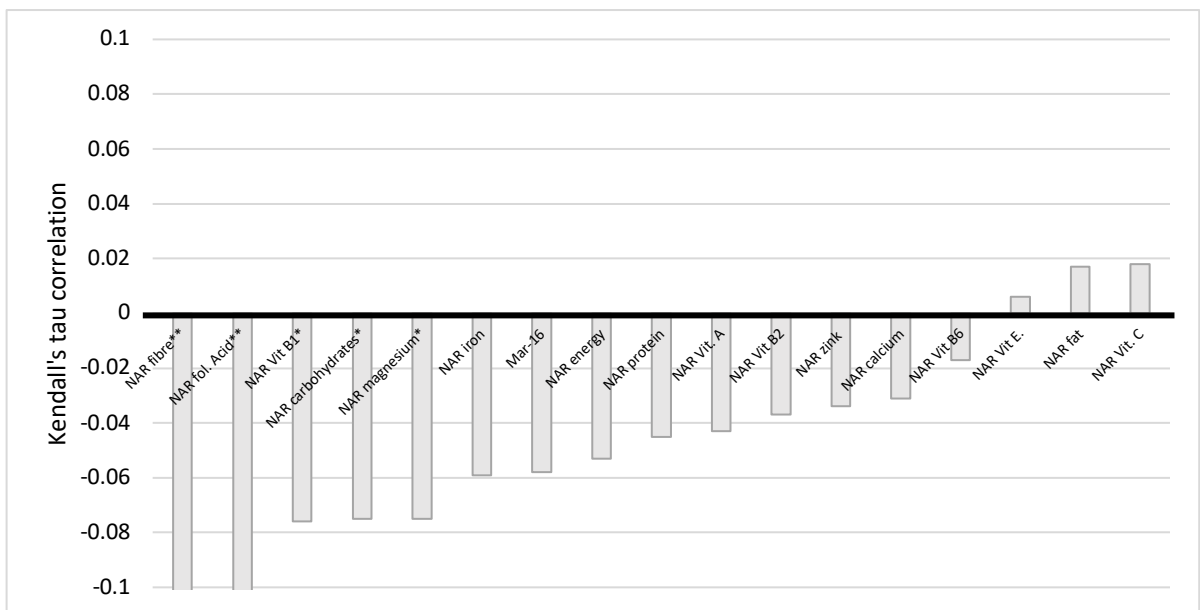


Figure 17. Correlation of NAR for nutrients with income

NAR – nutrient adequacy ratio; Mar-16 – mean nutrient adequacy for 16 nutrients \* p-value < 0.05; \*\* adjusted p-value < 0.05

The situation with education also indicates a similar trend (Figure 18). There is a very weak statistically significant negative correlation between education and NAR energy, carbohydrates, fibre, vitamin E and B1, folic acid, calcium, magnesium, iron, and Mar-16. The statistically significant difference persists even when corrected for multiple comparisons, except for NAR, vitamin E, and calcium. We conclude here that the higher the level of education of a woman, the less of the nutrients she obtained. BMI and NAR fibre have a statistically significant very weak positive correlation (Figure 19).

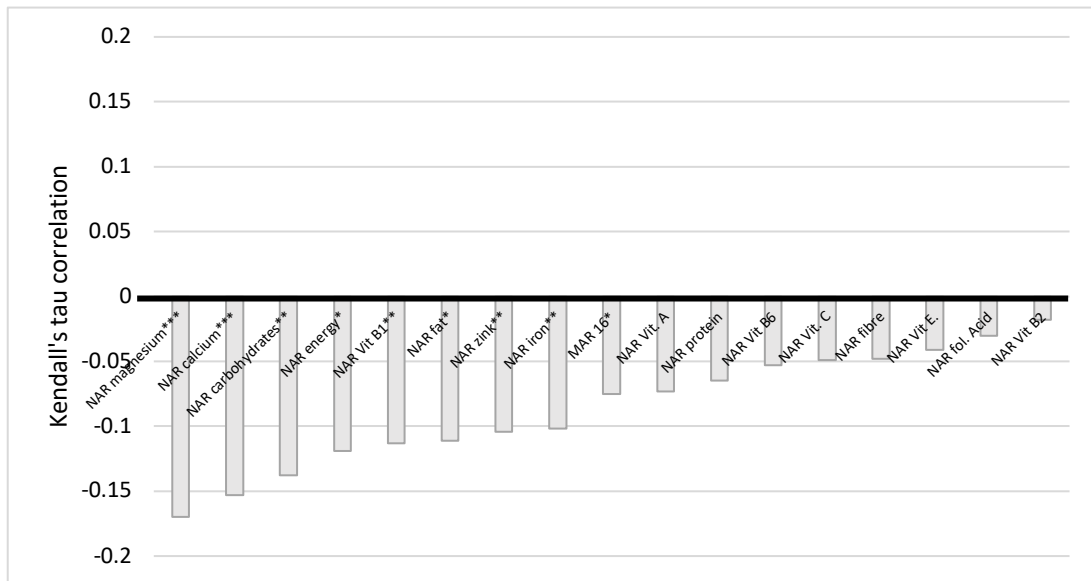


Figure 18. Correlation of NAR for nutrients with education  
 NAR – nutrient adequacy ratio; Mar-16 – mean nutrient adequacy for 16 nutrients, \* p-value < 0.05; \*\* adjusted p-value < 0.05; \*\*\* adjusted p-value < 0.001

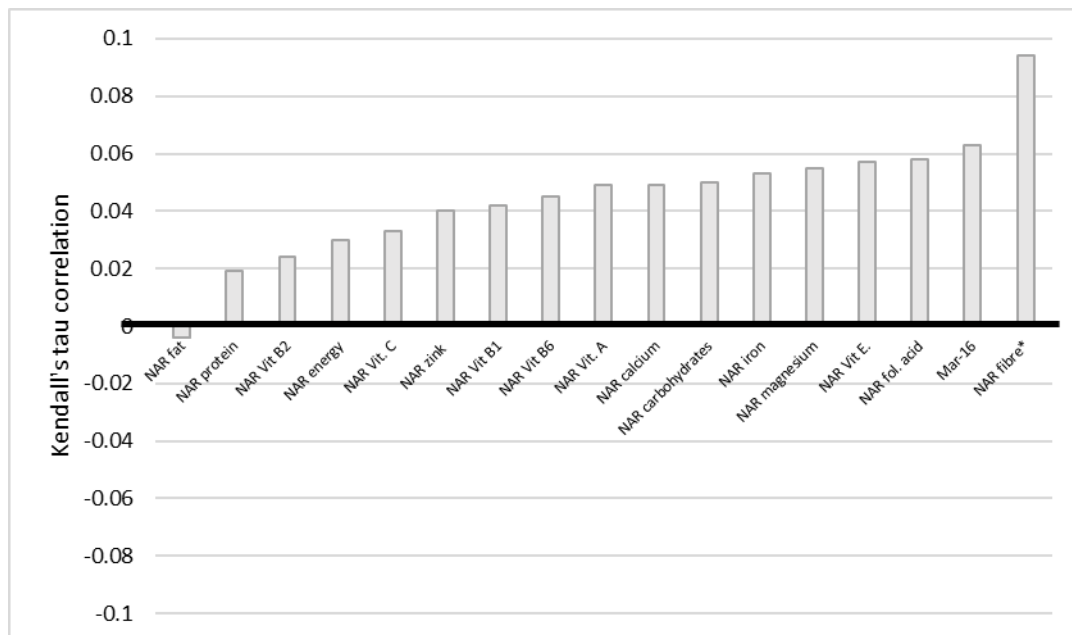


Figure 19. Correlation of NAR for nutrients with BMI  
 BMI stands for body mass index. NAR – nutrient adequacy ratio; Mar-16 – mean nutrient adequacy for 16 nutrients; \* p-value < 0.05



Residence of a respondent matters when it comes to nutrition. Our results show that when a respondent in the rural group was compared to the respondent in the urban group, the respondent from the urban group had higher NAR energy than the respondent in the rural group in only 41.7% of cases. In 58.3% of cases, women from rural areas had higher NAR energy than those in urban areas (Figure 20). When we compare NARs in urban and rural areas, we see that rural areas have better NARs for some macro- and micronutrients than those women residing in urban areas. This trend applies to NAR carbohydrates (urban for 0.36 and rural for 0.63), fibre (urban had 0.38 of cases and rural had 0.62), folic acid (urban was 0.43, rural was 0.57), calcium (0.43 in urban and 0.57 in rural), and magnesium (0.45 in urban and 0.55 in rural). All these results are statistically significant.

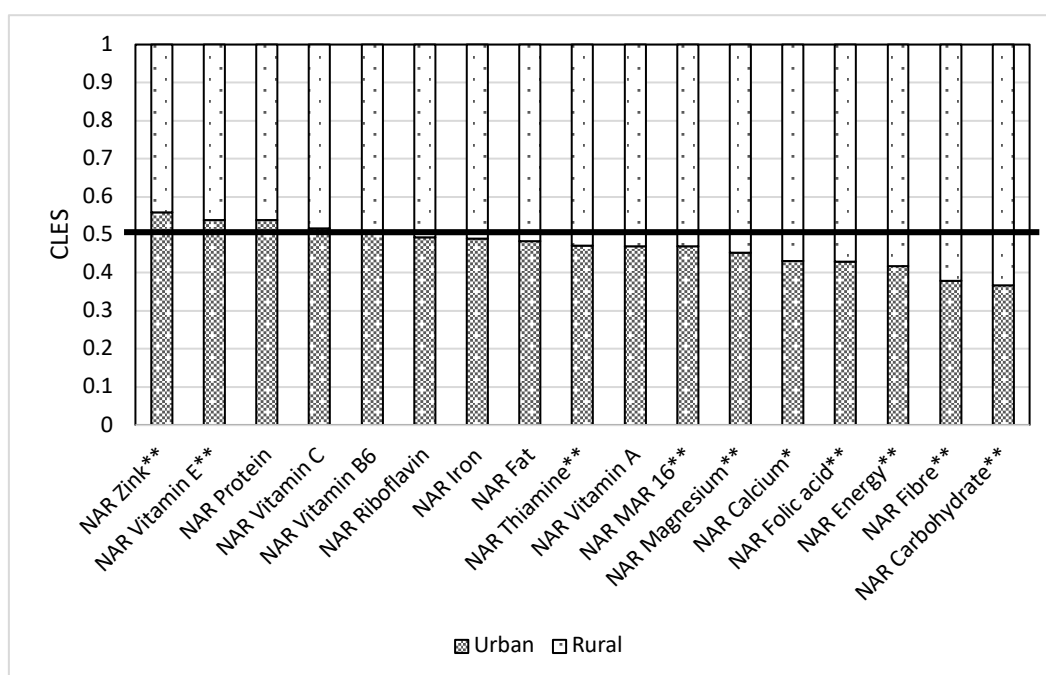


Figure 20. Comparison of NAR for 16 nutrients with urban and rural areas  
 NAR – nutrient adequacy ratio; Mar-16 – mean nutrient adequacy ratio for 16 nutrients; CLES – common language effect size; Wilcoxon p-value; \* p-value < 0.05; \*\*adjusted p-value < 0.05

We also compared women with a kitchen garden or cropland and found out that those who had them have better NARs for some macro- and micronutrients. In 42.9% of cases, women without a plot of land had better NAR for energy than those with plot of land. This means that 57.1% of women with plot of land had higher NAR energy than those without one (Figure 21). WRA with a kitchen garden or cropland had better NAR carbohydrate (0.60), NAR fibre (0.60), NAR vitamin B1 (0.53), NAR folic acid (0.54), NAR magnesium (0.54), and Mar-16 (0.54) than women without it.

Store distance is essential, as those respondents who live closer to the food market (less than 2 km) have better NARs for vitamins B2 and B6 (Table S4

Supplementary Material). Remittances play a significant role in ensuring nutrient adequacy. When comparing a group receiving remittances and a group not receiving remittances, we found out that the former had better NARs for carbohydrates (0.56), fibre (0.57), vitamin B1 (0.56), folic acid (0.56), iron (0.56), zinc (0.55), and Mar-16 (0.54) (Figure 22). Women who had at least one farm animal had better NAR carbohydrate (0.63), NAR fibre (0.63), NAR energy (0.58), and NAR folic acid (0.54). These results are also statistically significant after multiple comparisons (Figure 23).

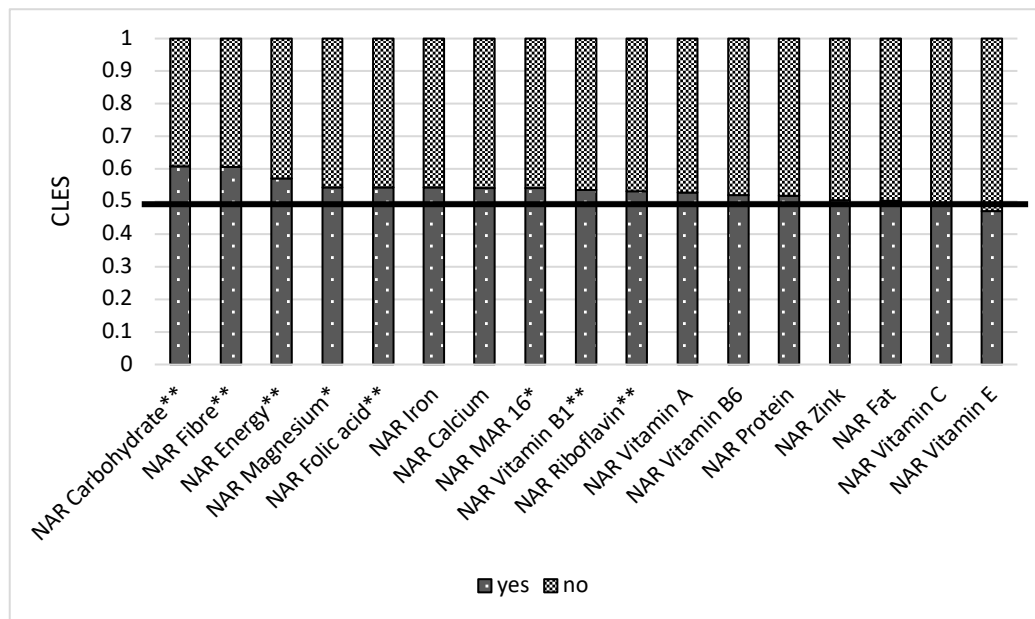


Figure 21. Comparison of NAR for 16 nutrients with the presence of kitchen garden/cropland  
 NAR – nutrient adequacy ratio; Mar-16 – mean nutrient adequacy ratio for 16 nutrients. CLES—  
 common language effect size; Wilcoxon p-value; \* p-value < 0.05; \*\* adjusted p-value < 0.05

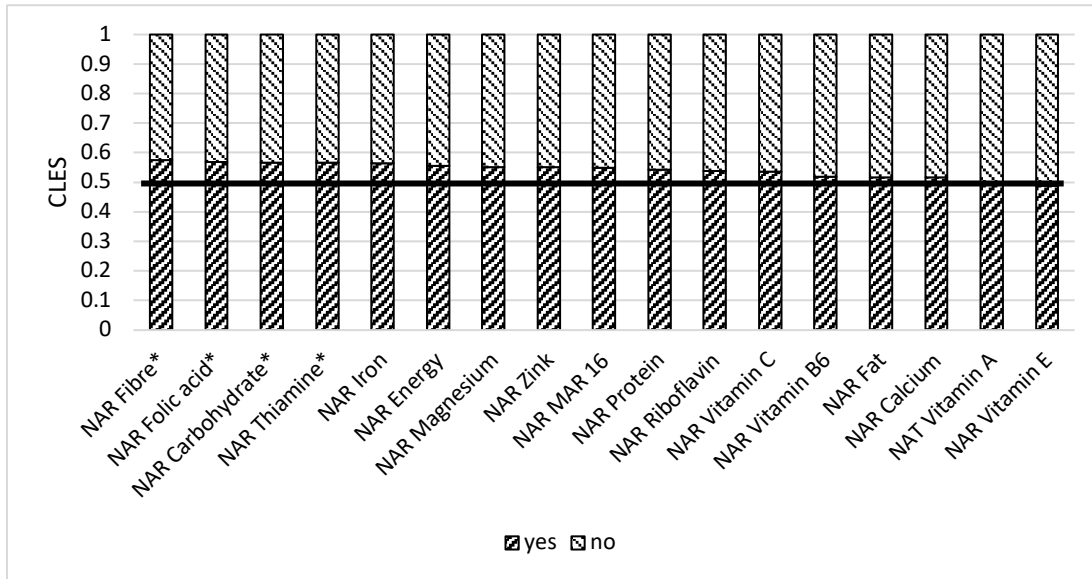


Figure 22. Comparison of NAR for 16 nutrients with getting remittances or not  
 NAR – nutrient adequacy ratio; MAR 16 – mean nutrient adequacy ratio for 16 nutrients. CLES—  
 common language effect size; Wilcoxon p-value; \* p-value < 0.05

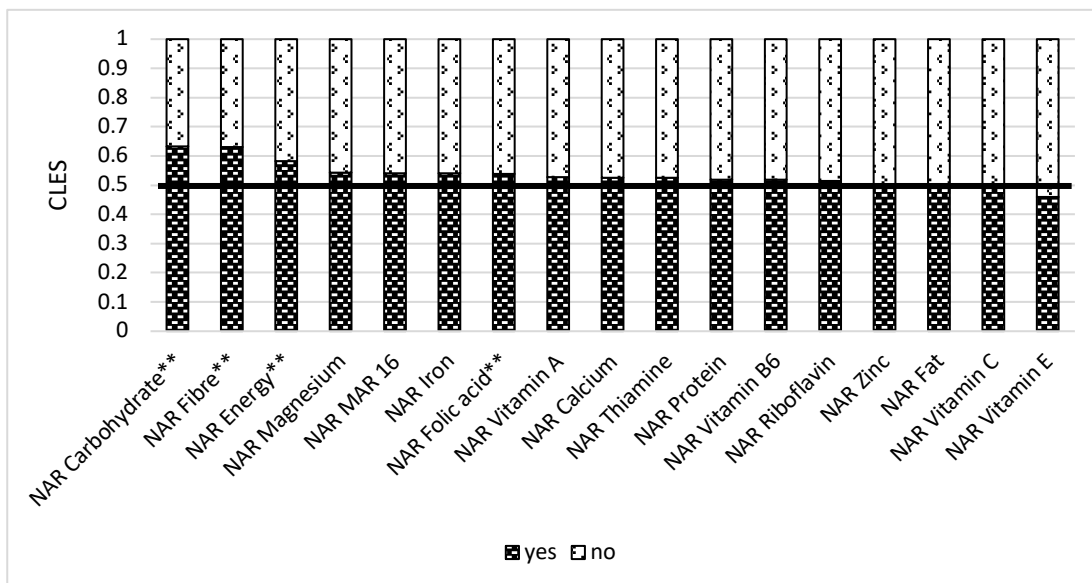


Figure 23. Comparison of NAR 16 nutrients with having at least one farm animal or not  
 NAR – nutrient adequacy ratio; Mar-16 – mean nutrient adequacy ratio for 16 nutrients. CLES—  
 common language effect size; Wilcoxon p-value; \*\* adjusted p-value < 0.05

#### 4. Discussion

The study aimed to understand diet diversification, nutrient adequacy, and its determining factors among women between ages 18 and 49 residing in low-income communities in Kyrgyzstan. Analysis showed that women in rural areas have more diversified diets than those living in cities. Consumption of simple carbohydrates (white rice, wheat noodles, white bread) along with traditional foods based on meat and milk products was popular among the respondents. On the other hand, intake of

plant-based protein (legumes, nuts, pulses) together with other fruits and vegetables was quite low. Assessment of nutrient adequacy for 16 nutrients showed that women in our samples do not obtain sufficient micronutrients, minerals, and vitamins from their daily diet. Shortage persists, especially in iron, magnesium, calcium, folic acid, and vitamins C, B1, B2, and B6.

Our results also indicate that nutrient adequacy is better in rural areas as well. Having a plot of land or kitchen garden and possession of a farm animal seem to positively impact the nutrition of women. Women receiving remittances also have better NARs for carbohydrates, fibre, vitamin B1, folic acid, iron, zinc and Mar-16.

Malnutrition can be in many forms, including hunger, obesity, and micronutrient deficiency [60]. Our results are similar to many other studies [4,32,33,61] and showed that cereal-based nutrition is common among WRA. In our sample, a woman's diet was mainly based on noodles, bread, rice, buckwheat, potatoes, and other starchy foods. Meat and its homemade products have the most crucial role in nomadic cuisine. It is the main dish for guests served in any Kyrgyz home in different variations, including as an ingredient in salads. Meat is mostly served with noodles, the traditional food named *bishbarmak*. It is even believed that meat consumption makes one healthy, and children from a young age are given meat and animal fat. Our results showed that meat, organ meat, and poultry were the second-highest reported food group. However, low-income families may have difficulties in buying meat due to its high price. We think its consumption might be lower than reported. Similar to in Afghanistan [7], milk consumption is high among Kyrgyzstani women. Nuts and seeds, lentils, and other fruits and vegetables constitute a little portion of most women's diets in our sample.

#### 4.1. Socio-Economic Factors and Nutrition Adequacy

For the last 20 years, Kyrgyzstan has overcome critical nutrition challenges. It happened due to poverty reduction, remittances, health sector reforms, and the improved nutritional status of women and children. Several nutrition intervention programs were introduced in Kyrgyzstan, such as salt iodization, sprinkles, micronutrient powder, and food fortification [23,43].

Regardless of these improvements, Kyrgyzstan spent much fewer resources on maternal health in relation to child health [25]. Policies for improving child health and nutrition often overlook the role of a mother. Maternal health has been discussed in the context of child health due to the various intervention programs introduced to improve child nutrition. Resources have been so far directed to enhance child health while its lesser share has been allocated to the future mothers' health and nutrition in Kyrgyzstan. Unfortunately, it seems to be a global trend [62]. Some micronutrient determinants remain poor among WRA. Women with monotonous diets and low dietary diversity tend to have micronutrient deficiency [63].

Several studies show that education positively impacts DD [32]. Our analysis found no statistically significant correlation between DD and the education of women and a very weak negative correlation between some NARs and education. These results also apply to income. Educated women tend to work and have higher

payments. This might negatively impact her nutrition. Meal skipping was common among WRA in our sample, especially in urban areas. Working women have challenges organizing time for cooking, although they obtain more income than a housewife. Time was a limiting factor in another study as well [4]. Limited time for cooking might negatively impact nutrition, and this situation conversely impacts DD. Other studies also show that women's education does not influence their diet quality [10]. Improving knowledge on proper nutrition should be performed [61]. Strategies for food preservation and its later consumption were common among households 30 years ago. Traditional cuisines of nomad food culture entail preservation methods such as drying, salting, and fermentation. Exploration of these methods and knowledge sharing could be one of the strategies for fighting malnutrition among WRA.

Empowered women tend to feed their children and consume diverse diets [38]. According to a study, education and advocacy positively impacted DD [61]. Nutrition knowledge and awareness are among the main determinants of DD [4]. Classes on nutrition and home economics should be an integral part of the school program [32]. A previous study indicated that [38] diverse food production is associated with diverse diets for children and women. These critical aspects should be considered when developing food and nutrition policies.

Socio-economic determinants played a crucial role in reducing stunting and improving nutrition due to remittances sent by migrants. Migration is critical for enhancing household food security and diet diversification [42]. Migrant-sending communities gain benefits through receiving remittances by improving their nutritional status. A number of studies state that food security is positively associated with migration and remittances [64,65]. Cash transfers improve the dietary diversity of women [66]. Results of this study also show that remittances positively impact the nutrient adequacy of women.

#### 4.2. Farm Determinants and Market Access

A study in India showed that kitchen gardens positively influenced household members' nutrition by increasing fruits and eggs intake [61]. Our results show that women with homestead gardens or plots of land have better DDS and better NARs for some macro-and micronutrients than those without one. It is an encouraging result, as our study also indicated that women residing in rural areas have a bit higher DDS than those living in cities. Almost all families own a plot of land (a few are rented) in villages in Kyrgyzstan. They tend to grow cash crops or fruits and vegetables. Although it may increase households' fruits and vegetable intake, the availability of kitchen gardens or cropland alone does not guarantee proper micronutrient intake [61]. Teaching farming techniques, efficient use of water, and marketing are essential skills for family members that need to be promoted. In addition to the availability of home gardens, agricultural training and nutrition counselling improve food security and dietary diversity [67].

Involvement in the food markets might positively or negatively impact DD. Some studies show that households engaging in food markets have more diversified

diets [35] and market participation, and they need access to improve the nutritional outcomes of families. The close location of households to the market and the more they participate, the better DD they have [36]. Markets can also facilitate food diversity during the lean season [7]. Compared to other studies [4], our research showed that market distance and whether households sell agricultural products or consume themselves have no statistically significant association with DDS. Although our study did not consider the volume of food production, these results contradict the previous study conducted in Nigeria [34]. However, some micronutrient adequacy was higher among those women residing close to the food market in our sample. Further research on this factor and improving sampling might also show the above-mentioned results. However, we still know that market proximity might improve nutrient adequacy.

### 4.3. Urbanization

Diets tend to change with urbanization processes. Consumption of fast food, semi-manufactured food, and street foods is common among urban dwellers. Poor and inadequate diets may likely be a significant cause of non-communicable diseases. The results indicate a presence of hidden hunger, where nutritional status based on BMI shows either normal (more than 50% of respondents) or overweight/obese (more than one-third of respondents). Still, NAR values for all macronutrients and micronutrients (except for Vitamin A and Zinc) are below 1. Worldwide, adult women tend to be more obese and overweight than men, leading to increased risk during pregnancy and to reproductive health [68]. Despite numerous food supplementation and fortification programs, micronutrient deficiencies are still high in Kyrgyzstan. According to [69], Kyrgyzstan belongs to the countries with a high presence of trans fats in popular products. We omitted unhealthy food from the results section, as it does not belong to the FAO 2021 food group classification. However, their consumption (pizza, hamburger, soda drinks, shawarma, *pirojki*, *belyashi*) was also high, especially in urban areas.

Legumes, green leaves, and fish seem to be widely consumed in African and South-East Asian countries. Compared to these cultures, Kyrgyzstan consumes more animal-based protein such as meat and milk products and less plant-based protein such as pulses and nuts/seeds. Fish is also rarely consumed, likely since Kyrgyzstan is a landlocked country with no access to seashores. On the other hand, Kyrgyzstan has a handful of rivers and lakes, but fish consumption is still limited among low-income families.

Agricultural products are the principal sources of most nutrients [12]. Consumption of diverse foods is both healthy and environmentally friendly. Negligence of local food varieties leads to biodiversity loss. Although our results show that some traditional foods are widespread among women in our sample, important nutrient-dense foods and wild foods are missing in their diet. Incentivizing women to consume locally available nutrient-rich foods is a reasonable strategy instead of promoting micronutrient supplementation, which is hard to afford for women in a low-income context [63].

DDS can partly be a proxy for understanding micronutrient deficiency. However, assessment of nutrient adequacy gives us a better picture and more detailed information on which elements are lacking in human organisms. Our analysis showed that WRA do not obtain sufficient micronutrients from their daily diet.

#### 4.4. Strengths and Limitations of this Study

This study has some strengths and limitations. Assessment of dietary diversity is performed with the calculation of intake of at least five foods from the FAO's ten food groups. This method is quite useful, as it requires fewer resources. Our article went a step further to assess nutrient adequacy for 16 macro-and micronutrients to better understand the diet of women in poor communities. This paper attempted to fill the gap of the nutrition literature by making an overview of consumption habits among women in Kyrgyzstan. The food culture of Central Asian nations alleviates the development of intervention programs directed at improving the nutritional status of local women.

A 24-hour recall is a commonly used tool to assess dietary intake for target populations. However, it has its drawbacks, as it might not entirely reflect the usual food intake of a respondent. Due to time and financial limitations, it was convenient for us to employ a 24-hour dietary recall. With sufficient resources, it is also exemplary to use three or seven-day recalls. However, an advantage of the 24-hour diet recall is the absence of memory bias.

We included 16 nutrients in our study because these were analyzed with the software Nutrisurvey (EBISpro: Willstätt, Germany, 2007). Other vitamins and microelements are vital for women of reproductive age, such as selenium, iodine, and others that are not part of this study.

Food security in rural areas depends on seasonality, which may impact micronutrient intake. Studies conducted in rural areas where food security depends on seasonality indicate that households had poorer dietary diversity due to high food prices and lower-income shortages [34]. Some longitudinal studies have shown that DDS is distinguished during the growing and harvesting season. As this study was cross-sectional, we captured the nutrition picture during the growing season between March and May. This study was conducted in the lean season. Harvesting season might have shown better DD similar to [1]. A post-COVID-19 situation in the country also may likely affect women's nutrition. The country's seasonal food availability and devastated economic situation after the COVID-19 crisis worsened families' status, which mostly lacked financial resistance. This might result in NAR being below 1 for most nutrients in our results. The exact effects of the pandemic on food security have not yet been assessed, but assumptions that stunting, wasting, and overweight rates might be higher exist [1].

#### 5. Conclusions

Lack of food security and adequate nutrition remain to be public health problems among low-income households in Kyrgyzstan. Results of this study indicate

that most WRAs consume starchy staples, flesh foods, and vitamin-A-rich vegetables. Meat and milk products are the sources of animal protein consumed by women. The calculation of mean NAR showed below 1 of energy, micronutrients such as vitamins B1, B2, B6, and C, folic acid, calcium, and magnesium and indicated malnutrition and hidden hunger. Despite favourable climatic conditions in Kyrgyzstan, fruits and vegetables are not widely used in the WRAs diet. Availability of a kitchen garden or cropland, farm animal, remittances, or residence area is associated with higher DDS and micronutrient adequacy. Education and income negatively correlated with DDS and nutrient adequacy.

The many programs of WHO, FAO, and WFP provide knowledge of nutrition principles, but nutrition policy is poorly provided at the state level. This paper employed RDI for Russia and Germany for the lack of similar government-approved recommendations in Kyrgyzstan. The development of an RDI for women in Kyrgyzstan is a fundamental step the government should undertake soon. The basis for the development of nutrition recommendations for specific groups should be performed considering cultural, climatic, historical, economic, and political factors. Altogether, Kyrgyzstan is undergoing a food system transformation. In coup with traditional cuisine, western-type nutrition is becoming common in cities.

Based on the findings mentioned above and discussion, the following recommendations should be considered:

1. Teach household members, including women on the organization of nutrition, food storage, planning of food intake for a week, and food preservation training at the household level.
2. Inclusion of nutrition classes in the curricula in kindergartens, schools, and universities. This is vital for establishing healthy eating behaviours for future mothers.
3. Agriculture should be diversified in the mountainous areas of Kyrgyzstan. Our field research noticed that households tend to concentrate their food production only on several crops. For instance, in the mountainous area of At Bashy, families predominantly grow starchy foods, such as potatoes and barley. While climatic conditions permit the growing of fruits and vegetables, people in the mountainous regions of Kyrgyzstan tend to avoid them, which might likely be due to the lack of experience of planting and developing them, remnants of nomadic food culture, and the current semi-nomadic lifestyle. In comparison to the mountainous area, households in the valley part Aravan grow various fruits, vegetables, and dark green leafy vegetables, such as figs, lemon, dill, parsley, coriander, quince, persimmon, carrots, chives, etc. Diverse food production should lead to diversification of household members' diets. Therefore, we recommend the diversification of agriculture as a strategy for improving diet quality, especially in mountainous villages.

**Supplementary Materials:** The following are available online at [www.mdpi.com/xxx/s1](http://www.mdpi.com/xxx/s1), Table S1: Socioeconomic and demographic variables and DDS (Kendall tau correlation), Table S2: Socioeconomic and demographic variables and DDS (Wilcoxon test), Table S3: Relationships between NAR for macro-and micronutrients and some socioeconomic indicators, Table S4: Factors determining diet adequacy



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## Chapter 4. General discussion

Due to the globalisation processes, nutrition transition is inevitably taking place in LMICs, including Kyrgyzstan. This chapter will make an overview of key results, discuss how homestead garden impacts dietary diversity, analyses traditional foods and ultra-processed foods (UPFs) present in women's current diet, the possible implications of COVID-19 crisis on the food system and discusses strengths and limitations of this research study.

### 5.1. Summary of the key findings

This dissertation pursued several study objectives. First, it aimed to explore whether and how nutrition transition has been taking place in Kyrgyzstan and explore where the state is situated in terms of nutrition transition stages. The primary result indicates that political and economic transformations which took place in the Kyrgyz society for the last 170 years impacted nomadic food culture. First, Kyrgyzstan underwent the tribal system; then socialism was introduced by the Soviet government, which was followed by liberalisation of the economy. These three political systems entailed changes in agriculture, lifestyle, economy, and diet. The tribal system is characterized by traditional nomadic cuisine based on meat, intestines, a variety of milk products, fermented mare's milk, beverages based of grains, and berries, fruits, vegetables, medicinal plants, and herbs grown in the wild. It was seasonal, low in fat and high in fibre and carbohydrates, coupled with high physical activity. With the entering socialism, collectivisation of farms, the emergence of the first urban areas, domestication and introduction of new crops, settlement of the nomads took place. The introduction of the nutrition policies based on subsidisation of animal-based products was aimed at increasing the energy intake of devastated human organisms due to the hunger which occurred during the WWII. Moreover, the shift to technology and concentration of agricultural production on animal husbandry, cotton, rice, and wheat led to the increase of food production in comparison to the previous system. These changes were concomitant to the dietary changes which were associated with a sedentary lifestyle. The latter implies less physical activity and having an energy-based diet.

Liberalisation of the economy led to the flooding of the local market with UFPs (ultra-processed foods) and became sign of welfare as mostly well-off families could afford the expensive imported food products. With the development of the economy and rise of GDP, undernutrition rates have shrunk, and obesity has been rising in the country. Demographic and economic growth, urbanisation, growth of food production are changes that have been occurring in independent Kyrgyzstan. In line with the nutrition transition theory, NCDs have been rising, whereas communicable diseases are declining.

Women of reproductive age (WRA) belong to the part of the population that tend to suffer from the triple burden of malnutrition, including micronutrient deficiency. The second set of questions set forth in this work was to investigate determining factors of dietary quality of WRA residing in low-income settings. The findings include that WRAs in low-income contexts have serious issues related to the lack of energy and micronutrients in their organisms. While their mean BMI was 24.2kg/m<sup>2</sup> and more than a third of respondents were either overweight or obese, these women suffered from hidden hunger. Their mean DDS was 4.71, indicating low dietary diversity. Based on 24h diet recall, it was revealed that they were generally short of iron, magnesium, calcium, folic acid, zinc, vitamins C, B1, B2, B6, and E. Monotonous, cereal-based, nutrient-poor and energy-dense diets contribute to the development of hidden hunger. Consumption of simple carbohydrates (white rice, wheat noodles, white bread) along with traditional foods based on meat and milk products was popular among the respondents. On the other hand, intake of plant-based protein (legumes, nuts, pulses) together with other fruits and vegetables was quite low. Interestingly, vitamin A was sufficiently obtained from the diet when the survey took place. This might be because the intake of carrots, liver and milk products was common. Additionally, the results show that women residing in rural areas had better diets quality than their counterparts in urban areas. The findings also suggest that respondents who had a plot of land, a kitchen garden, or at least one farm animal generally had better diet quality than those without one.

## 5.2. Nutrition transition in Kyrgyzstan and importance of mixed methods approach

Global dietary patterns have been transforming for the last centuries. In Kyrgyzstan, we could observe transformations in lifestyle and diet for the last 170 years. The reason for choosing this timespan was the three political and economic systems that the country has gone through. They inevitably influenced transformation of food culture.

We have not had plausible and comparable data for dietary intake in Kyrgyzstan up to now. Therefore, it was hardly possible to compare dietary intakes under different political systems due to the lack of data, its non-accessibility or incomparability. Therefore, a mixed methods approach with two stages permits us to explore this complex phenomenon employing qualitative and quantitative methods. Additionally, using inductive and deductive approaches [1] allowed me to underline the existing theoretical basis, extract a methodological approach from it, outline trends and patterns and observe the real-world data and vice versa. Understanding the peculiarities of diet and lifestyle transition requires the usage of complex methodologies. Therefore, profound methodology based on qualitative and quantitative approaches served data collection through the conduct of expert interviews and thorough literature review followed by the survey.

Based on the findings, dietary patterns have changed over the last 30 years in Kyrgyzstan. According to classifications of food systems [2], Kyrgyzstan suits stage II and III characteristics. Features of these stages include urbanisation, income growth, involvement of women in the labour market, lengthening of supply chains, and increasing intake of imported, processed and street foods poor in fibre and more fat, sweeteners, and oil. Undernutrition, overnutrition, and micronutrient deficiency are present in stage III countries with rising chronic nutrition-related diseases [2].

Dietary changes based on the food balance sheets in Kyrgyzstan show that a shift towards increased animal fat supply, beans and peas, nuts, fruits and vegetables, and milk took place (Figure 24).

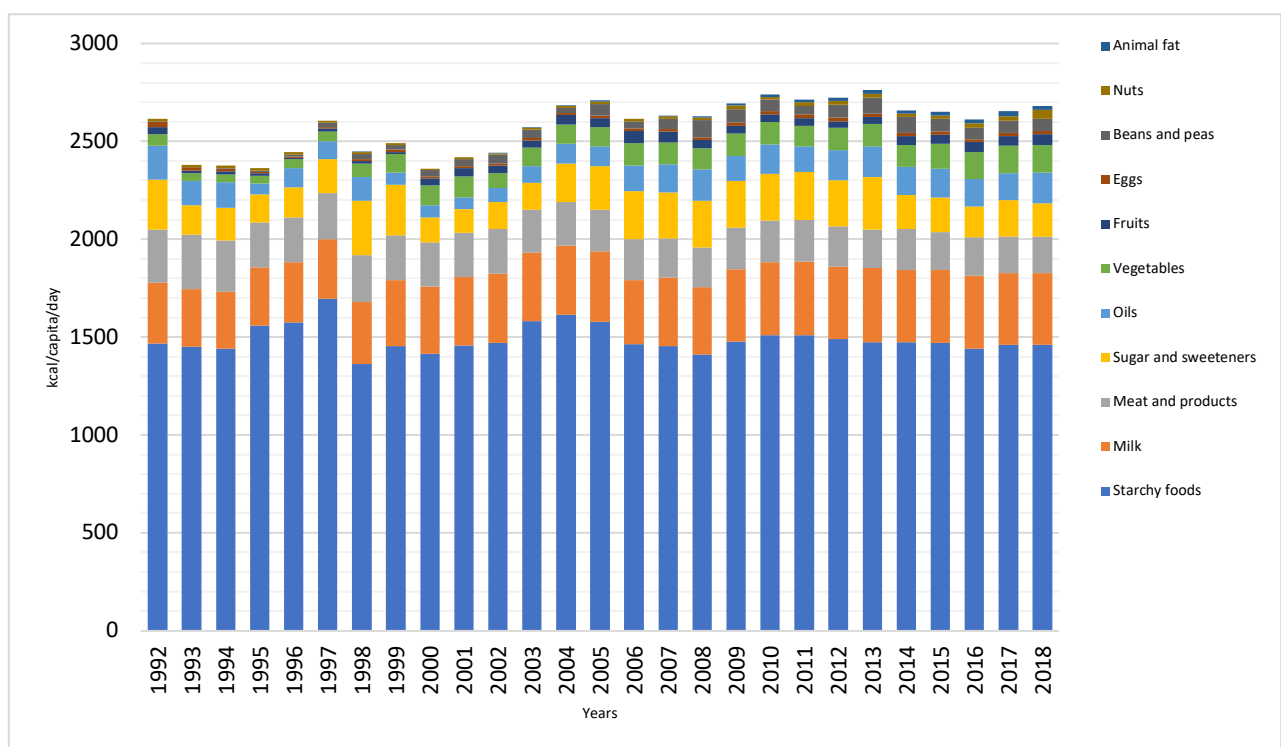


Figure 24. Food balance sheets, Kyrgyzstan 1992-2018 [3][4]

The supply of total foods estimated by in kg/capita/year increased from roughly 600 in 1992 to 780 in 2018 for the period 1992-2018 (Figure 25). The increase is due to the rise in starchy staples, milk products, fruits and vegetables, sugar and sweeteners, pulses and nuts. In 1993 there was a short period of economic decline, which also echoed in the food supply situation, as seen in figure 25. Since the 2000s the numbers remained stable with a short decrease in 2006-2008 due to the world food crisis. The results suggest that the overall increase of food supply in each food group are in line with the nutrition transition theory. However, other changes stated in theory have not occurred.

According to my results, traditional food is still a dominant part of the women's diet in urban and rural areas despite urbanisation and economic growth. Regardless of increased availability of ultra-processed foods (UPFs), traditional foods are still



popular. These results are consistent with the findings from other countries such as Indonesia [5]. As the theory predicts, urbanisation in Kyrgyzstan shows some differences in terms of nutrition. Although dietary diversity in cities was lower than in rural areas, urban respondents consumed more UPFs.

In most Western countries, diet-related chronic diseases are a major factor of sicknesses and mortality [6]. However, this trend – employment of Western dietary patterns – is spilling over in the LMICs as well, including Kyrgyzstan. As a result, a common belief that obesity is an issue of the high-income urban population is now doubtful.

The nutrition transition is taking place rapidly in developing countries. Popkin’s stage 3, receding famine to the phase 4 degenerative diseases showed that shifts in diets and physical activity are changing rapidly. The rate of change is faster in developing countries. The burden of obesity lays mostly on the poor [7]. Similar to Popkin’s analysis, overweight and obesity were a problem among around 36% of surveyed women. Based on this sample size, I conclude that women with high BMI (<25.0) also reside in low-income environments.

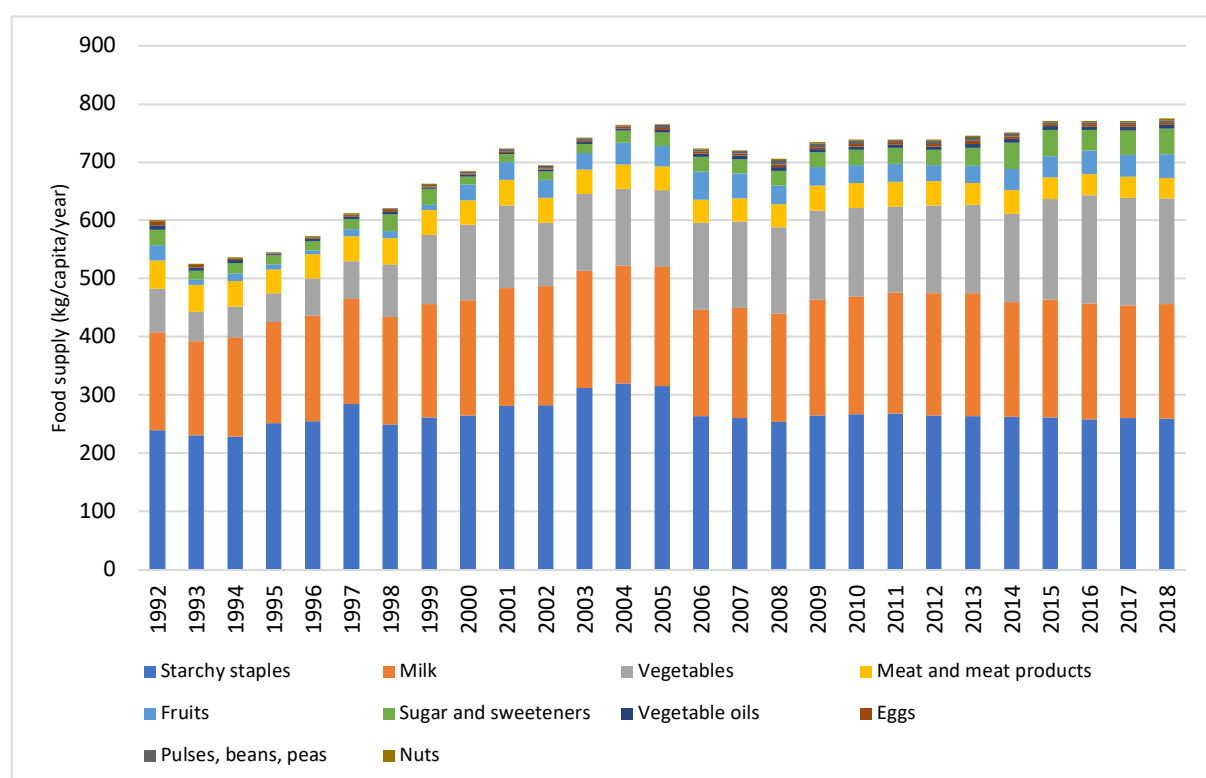


Figure 25. Total food supply (kg/capita/year) between 1992 and 2018[3], [4]

Due to the absence of household food consumption surveys on the national level, it is challenging to make precise estimations of a dietary shift. However, available statistical data indicates the supply increase of certain food groups during the last 30 years. Rise in supply in starchy staples, milk, vegetables, fruits, sugar and sweeteners, pulses, beans, peas and nuts is observed (Figure 25).

### 5.3. Consumption of traditional foods and UPFs

According to the nutrition transition theory, one of the signs of diet westernization is increasing urbanisation and the tendency to consume processed foods. Nowadays, dividing foods into processed and unprocessed categories is useless, as most foods currently undergo specific processing. Depending on the purpose and extent of industrial processing, foods have been categorized into four groups. According to the NOVA classification of food products: 1) unprocessed and minimally processed food, including natural parts of plants, fruits, vegetables, and animals; 2) processed culinary ingredients, including salt, sugar, vegetable oil, aromatic herbs used to preserve kitchen products longer and consume later; 3) processed foods which contain foods from the groups 1 and 2, examples are canned or bottled fruits and vegetables, salted nuts, freshly made bread, cheese etc. Additives may be added to preserve original properties or prevent contamination. 4) Ultra-processed food and drink products are foods that consist of many ingredients designed to improve taste and visual properties, usually with very little or no natural products. Additives used for UPFs are dyes, colour stabilizers, flavour enhancers [8].

Results of the survey indicated that consumption of both: traditional foods and UPFs are common among WRA. However, we see that the proportion of urban women consuming UPFs is higher than the proportion of rural respondents (Figure 26). At the same time, traditional food is similarly consumed in both urban and rural areas, and women in cities tend to skip meals. However, the findings suggest that traditional foods are the primary sources of vitally important elements because 90% of WRA reported consuming at least one type of traditional food during our 24h diet recall. Meanwhile, 60% of urban women said that they had UPFs during the last 24 hours when the survey was conducted.

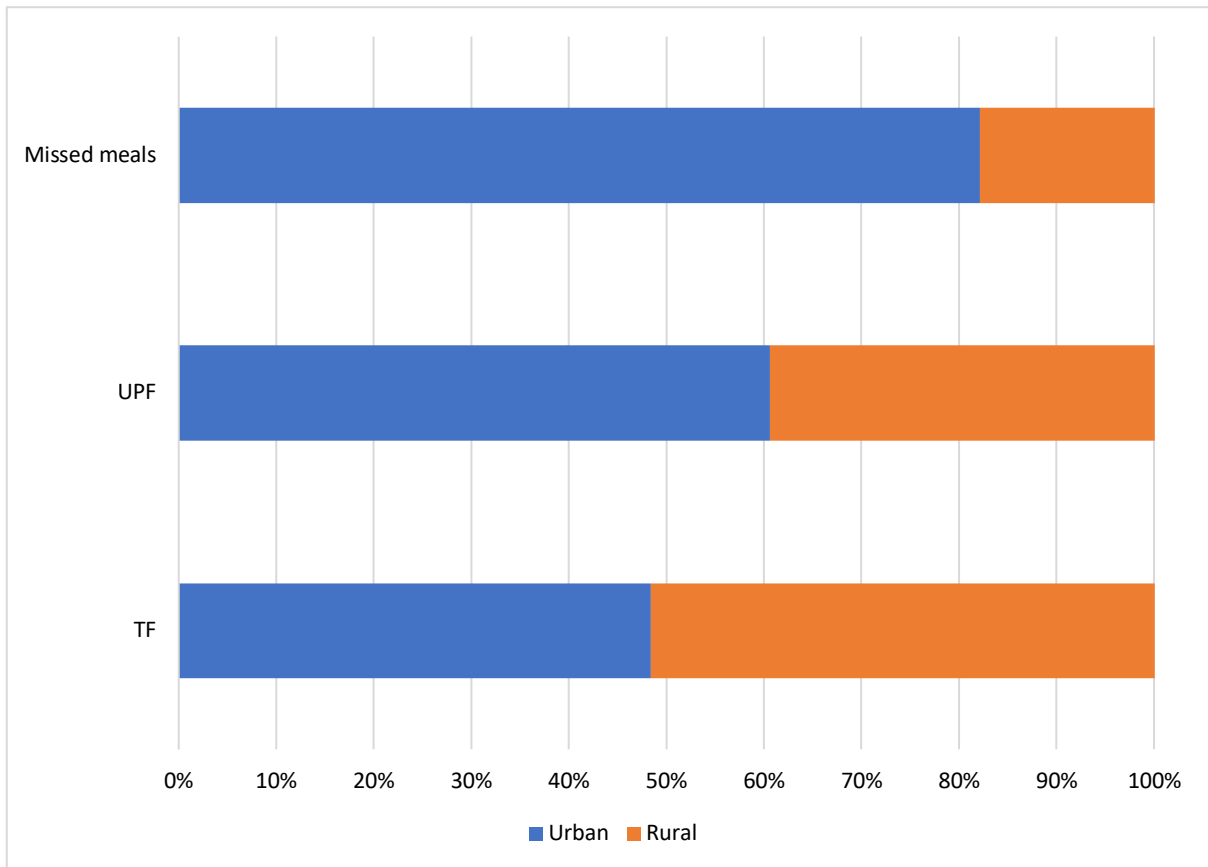


Figure 26. Consumption of TF and UFP and missed meals in urban and rural areas  
 UFP – ultra-processed foods according to the NOVA food classification system; TF – traditional food

Among the UPFs, women reported having consumed the following food items (Table 12).

Table 12. Consumption of UPFs classified according to the NOVA system among WRA

| Name of UPFs                              |
|---|
| Instant noodles                           |
| Cola, pepsi                               |
| Cookies                                   |
| Processed meat (such as kolbasa, sosiska) |
| Fruit juice (sweetened)                   |
| Pastries, cakes                           |
| Pre-prepared pizza                        |
| Chocolate and candies                     |
| Fruit yogurt                              |
| Waffles                                   |
| Pre-prepared packaged fish and meatballs  |
| Pre-prepared poultry nuggets              |
| Hamburger                                 |
| Shawarma                                  |
| Ice-cream                                 |

Consumption of such food products might result in serious health problems in the long term. UPFs may contain limited foods of natural origin [9]. Coupled with the current sedentary lifestyle with limited physical activity, diets based on processed foods, including sugary drinks and short of minerals, vitamins and fibre lead to degenerative diseases. Weight gain, cardiovascular and autoimmune diseases, insulin resistance, decreased HDL cholesterol, blood pressure are the results of Western diets [10]. Ultra-processed foods are a major contributor to the obesity pandemic. In addition to this, production processes and ingredients used for UPFs have a negative ecological impact on the environment [11].

Traditional foods constitute a significant portion of the diet in Kyrgyzstan. This is also confirmed in similar studies (Kokaisl, 201). Based on a study about street foods, it was found out that westernized foods were more expensive than traditional foods. Given this fact, promoting traditional foods is an important way to improve the nutritional status of the population. This is especially beneficial and nutritional, taking into account the abundance of vegetables and legumes in them [12]. Another study in Bishkek found out that industrial foods/Westernized foods are often purchased. These include soft drinks, meat-based dishes, pastries, cookies and sweets and minimal purchase of fruits [13]. Consumption of street foods is frequent in Bishkek. Street foods are energy-dense, have much saturated fats and trans fats and sodium, which in the long-term might negatively impact the health of the population. Policies should include knowledge dissemination through legislation and labelling. These policies should be strategies for preventing NCDs, food and nutrition security programmes [13].

On a global and regional level, women tend to have a higher prevalence of food insecurity than men. In 2019, around 30% of WRA suffered from anaemia. For the last two decades, the anaemia of WRA has not improved. Additionally, obesity among adults is rising globally. Food security and nutrition are undermined by various drivers of food security, especially in low- and middle-income countries. Income inequality increased in low- and middle-income countries in 2020.

The SDG 2 calls to end hunger, achieve food security and improve nutrition and promote sustainable agriculture (SDG, 2021). In the framework of this goal, it is recognized that micronutrient deficiency among WRA can have long-term health effects. While it is believed that the problem of hunger is primarily rural, a segment of the poor in urban areas is also serious. Capital concentration in urban cities prompts rural residents to move to urban areas in search of better livelihoods. These tend to form communities within and in the suburbs of large cities, mainly occupying low paid unstable jobs, whose payments depend on a day-to-day basis.

Around 2.37 billion people globally could not afford food and a healthy balanced diet in 2020 daily. Pandemic harshly impacted around 720-811 million people who suffered from hunger in 2020 (The Sustainable Development Goals Report 2021). Smallholder farmers producing food often become vulnerable to hunger in times of instability. During the last 30 years, Kyrgyzstan has undergone social, economic, and political transformations after the dissolution of the Soviet Union in

1989. The disintegration of the collective farms, destruction of industry and trade [14]. The transition from socialist to market agriculture has been challenging for many smallholder farmers [14].

The absence of a food composition table and recommendations on food intake for WRA in Kyrgyzstan put certain obstacles for conducting this study. As Poulain [15] mentioned, one of the limitations of the nutrition transition theory is its reliance on national data. This study highlights that food inequality on a lower level exist. Depending on the income geographic location, the population part might be in different stages of nutrition transition. Section of the population in a lower income context might be in stage 2 or 3. Lack of financial resistance might throw them to the stage of hunger.

#### 5.4. Kitchen gardens positively impact nutrition quality

Traditional nutrition intervention strategies, including supplementation and fortification, have been employed in a number of countries. These interventions require considerable human and financial resources. Traditional nutrition interventions may not be acceptable for rural and disadvantaged women [16]. Some such programs in Kyrgyzstan showed that mistrust among women in rural communities was present. Moreover, some interventions did not include the peculiarity of local food culture. For example, micronutrient sprinkles have been introduced and were supposed to be added to the food in warm-like conditions to be effective. But, locals predominantly consume food in a hot state, for example, consumption of hot soups is common. Similar misunderstandings might hinder the effectiveness of such programs. Therefore complementary strategies should be enacted to promote unorthodox methods such as the introduction and enhancement of home gardening [16].

The promotion of nutrition-sensitive agriculture complements existing nutrition interventions to deal with micronutrient deficiency. These strategies are not competing ones but rather complementing [16]. Considering that Kyrgyzstan is an agricultural country, the advancement of agricultural practices to improve household food security should be prioritized. Our results showed that women having a plot of land or kitchen garden or at least one farm animal had better dietary diversity and slightly higher magnesium, folic acid, iron, calcium, riboflavin, and vitamin B1 levels.

Household food production fortifies food sovereignty by serving as a backup for families, especially in times of global food supply instabilities and price volatility. Furthermore, in times of economic transition, growing fruits and vegetables might decrease households' propensity to consume obesogenic foods [16].

These findings are in line with several studies arguing that home food production positively impacts the nutrition of households' members. Home gardens showed a positive effect in intervention programs when combined with the traditional interventions. In a quasi-experimental study in rural Guatemala, when conventional

nutrition improving mechanisms were combined with the provision of garden materials, classes on gardening and an agronomist's monthly visits, child and maternal dietary diversity and household food security improved. Seeds for crops rich in vitamins A and C, folate, protein, and iron were provided [17].

When designing nutrition interventions with home gardens, it is important to understand that one size does not fit all. Not all such interventions can be successful. Programs should be designed taking into account local context and perceptions, attitudes and practices in relation to homestead gardens [18]. The promotion of gardens in urban areas also show positive feedback. Participants of an urban home garden program stated that fast food consumption decreased while availability of fresh foods, increased food quantity, and home cooking allowed them to lose weight and have healthy diets [19].

A slight increase in vegetable production was observed in Tanzania after the home garden and nutrition intervention [18]. However, home food production may not always translate into improved nutrition of the households' members. Families may produce high-quality food and sell it in the market and purchase low-nutrient staple foods [16]. Moreover, it is also not obvious whether food production at a household level impacts the diet indirectly (through the market factor and increased income) or directly through the consumption of quality foods they produce [16].

In the contexts where diets are primarily based on cereals and home food production and informative sessions, other strategies such as supplementation and fortification should be added to increase iron levels [16]. A complex approach to fighting malnutrition is important.

## 5.5. Importance of locally available foods and biodiversity

Micronutrient deficiency is a global public health concern. In the population of women between 18 and 49 that we studied, the intake of vitamin E, B1, B2, B6, C, folic acid, calcium, magnesium, iron and zinc was significantly lower than the recommended level. Lack of these nutrients may not be observed physically, but they have a long-term impact on a women's health and her future offspring.

Women in our sample experience a lack of several vitamins and minerals. Low consumption of fruits and vegetables among low-income families is primarily due to their high price. Fruits are also major contributors of other vitamins such as folate, potassium, vitamins A and C [22]. Sea buckthorn (*Hippophae rhamnoides L.*) is grown in mountainous areas of Kyrgyzstan and can potentially contribute to the fight with micronutrient deficiency. It is rich in vitamin A, C, B1, B2, E, K and others. In Kyrgyzstan, it belongs to wild plants, and its vitamin C content reaches 181.88mg/100g [23]. Consumption of locally available foods would be a plausible strategy to fight malnutrition [24].

We found out that low dietary diversity contributes to micronutrient deficiency. Low consumption of pulses, legumes, nuts and seeds, fruits and vegetables lead to poor nutrient adequacy. Promotion of locally available nutrient-rich foods along with educational programs and social support should be prioritized [25].

In comparison to other countries [26], WRA in Kyrgyzstan obtained almost the necessary amount of vitamin A from their daily intake. Findings in other countries show that living in big cities contributes to dietary diversity [27].

Each country stands at a different stage of nutrition transition. Our results showed that women suffered from both macro- and micronutrient deficiency. Dietary diversity is a plausible indicator of micronutrient deficiency for women of reproductive age in Kyrgyzstan. However, investigation of micronutrients gives a better picture to understand and develop targeted programs.

### *Biodiversity loss*

Traditional food systems have benefited from the variety of food nature has been providing the humanity [28]. Humanity needs to protect biodiversity as it, among others, provide diversity which our current food system is lacking. Recent studies on underutilized foods, including fruits and vegetables, show the potential to fight malnutrition in many cultures. However, it is believed that the production of neglected indigenous foods is not associated with high dietary diversity. A study in Nigeria showed that producers of such foods' diets are based mostly on starch [28]. These might be because the producers do not consume the indigenous foods themselves but rather sell. Regardless of that considering the neglected wild plants should be in nutrition programs. Monotonous diets, namely intake of macro- and micronutrients and antioxidants might be affected by limited food choices, which are the result of low biodiversity. Reduced micronutrient consumption might be due to biodiversity loss and low food choice [29]. A similar study in Bangladesh indicates that DDS among WRA was also low at 4.63, but their diet was dominated by dark green leafy vegetables, besides grains [30]. Green leafy vegetables were not popular among the respondents in this study.

## 5.6. COVID-19 and food security measures

Before the COVID-19 pandemic, food security has generally strengthened in Kyrgyzstan due to an increase of food availability and economic affordability. But the use of food and stability of food situation has been doubtful. First, because of the increasing number of non-communicable diseases and issues related to growing cases of overweight and obesity as well as micronutrient deficiency. Second, the stability of the food system is affected by economic and climatic variabilities [20].

Economic shocks that resulted from the COVID-19 pandemic affected households with unstable incomes in Kyrgyzstan. Recent reports state that poor

families had to compromise nutrition in order to survive in an unstable situation with jobs. 44% of families had to decrease expenses on food. During January and August of 2021, prices for cereals, meat, vegetables, and milk products increased by 18.8% in comparison to the prices in the same period 2020. Consumption of energy-dense foods such as bread, sugar and oil increased, and intake of fruits and vegetables decreased [21]. The Ministry of Health and Social Development provided one-time food support to 523,880 people [21]. Civil society's engagement in alleviating the food burden on disadvantaged communities was enormous.

## 5.7. Methodological and data limitations and societal implications

Some strengths and limitations of this dissertation should be highlighted. To the best of our knowledge, it is the first study that analyses nutrition transition in Kyrgyzstan, focusing on WRA. Our data sample was representative, including different ethnic groups, regions, rural and urban settings, different age groups, women with various occupations. However, findings can refer only to the women who participated in the survey and cannot be generalized to the entire country.

This study does not replicate the diet westernization similar in some LMICs, because traditional foods are still an essential part of the diet. 24h diet recall has a recall bias, and its quality depends on the interviewer [31]. 24-hour diet recall diminishes recall bias in comparison to 7-day diet recall [32].

Findings in rural Pakistan also show that in a community, overweight and obesity, together with micronutrient deficiencies among WRA exist [24]. Considering nutrition transition in Kyrgyzstan in the context of the USSR poses additional challenges due to the lack of data and/or available data is difficult to compare with the statistics obtained after the 1990s. During the Soviet Union, nutrition data was based on the collection of different information.

To achieve food and nutrition security, Kyrgyzstan emphasized trade rather than self-sufficiency [33]. The Law on Food Security in the Kyrgyz Republic from 2008 does on a legislative level food security includes nutrition as well [33]. Existing policies include compulsory flour fortification with folic acid.

Due to the pandemic, 83% of migrants either lost their job or have decreased salaries in Central Asia. Rising food prices hinder access to food. Prices for wheat and flour increased by 25-30%. Prices for fruits and vegetables, meat, fish, milk products and cereals also increased on average by 17.3% [34]. Given the pandemic situation, rising inflation rates and food prices make it difficult for households with weak financial resistance to ensure proper nutrition [34].

National dietary guidelines should serve as the foundation for policy development. It is also an underlying tool for raising public awareness on issues related to undernutrition and overnutrition. Countries like Qatar, Brazil, Germany, and Sweden have dietary guidelines with a holistic approach to ensure environmental



sustainability and social equity and diet quality and human health [35]. Such holistic approach should be employed in Kyrgyzstan as well.

## 5.8. Policy recommendations

With the decreasing undernutrition rates and increasing obesity rates globally, a similar trend is taking place in Kyrgyzstan as well, albeit at a slower pace (in comparison to China). No country so far could decrease its overweight and obesity rates [11]. Therefore, it is vital for Kyrgyzstan to concentrate on preventive measures because it is easier to avoid the growing number of people with BMI beyond 25 before reaching the point some LMICs already have. As a rule, prevention activities require less resources than fighting overweight, obesity, and nutrition-related NCDs. In a business-as-usual scenario, we might experience a further increase in obesity and overweight rates in the near future. Therefore, primary policies should be directed at decreasing consumption of UPFs and changing lifestyles.

Policies should concentrate on fighting with micronutrient deficiency and ensuring food security and focus on preventing NCDs through promoting healthy diets [36]. Food-based strategies should be promoted as they are more sustainable than traditional strategies to fight micronutrient deficiency [16].

Population-based policy approach should be prioritized through awareness programs, communication strategies, the introduction of taxes to sugary beverages, restricting certain marketing strategies directed at children [36]. In a policy simulation analysis, it was revealed that sugar-sweetened beverage (SSB) tax together with subsidies on fruit and vegetable would be a compelling incentive to purchase less SSB and more fruits and vegetables for low-income families [37]. Some policies include fiscal measures, marketing regulations, labelling. Actions directed at increasing awareness and knowledge should be promoted in all parts of the country. Another policy recommendation is to subsidise healthy products and introduce taxes to junk foods. This measure might impact consumer preferences [38].

Our results showed that consumption of animal-based protein is relatively high. Policies should be directed at reducing consumption of animal-based products to alleviate the environmental burden employing less water, antibiotics, fertilizers and pesticides [39].

Previous studies showed that homemade street foods and industrial beverages in Kyrgyzstan contain sodium at high levels. Efforts should be devoted to decreasing salt intake by introducing regulations limiting sodium to food producers and spreading information among households [40]. Given the increasing cases of NCDs, including cardiovascular diseases and hypertension, strategies to decrease sodium in industrial settings and among individuals should be prioritized.

Further, creating a coordination body ensures a multi-stakeholder and multi-sectoral approach in managing food and nutrition security questions. Currently, the absence of such organ safeguarding engagement of governmental bodies, non-

governmental organisations, and the business sector creates difficulties in the harmonisation of activities.

The establishment of a nutrition discipline as an independent study programme at graduate level at the state universities is crucial. Currently, courses on basic nutrition, hygiene, dietology are taught to future specialists such as food engineers and doctors. Extreme shortage of nutritionists exists presently in Kyrgyzstan presently. Update of the courses content taking into account contemporary realities and challenges humanity faces should be performed. Sustainable nutrition embraces vital aspects such as environment, health, society, culture, markets, policy, etc. These should be included in the courses' content in order to ensure a holistic approach to this topic. Such a step will create the next generation of nutritionists with the mindset, skills and knowledge necessary to fight with the triple burden of malnutrition and achieve zero hunger in Kyrgyzstan.

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## Chapter 5. Conclusion

As nutrition transition is taking place globally, understanding its dynamics in LMICs including Kyrgyzstan, is vital. This dissertation made an analysis of changes in lifestyle and diet on macro-level and micro-level. On a national level, analysis of historical changes and patterns showed how the transformation of nomadic food culture underwent several economic systems and thus changed itself by incorporating new realities. It would be a timely decision for global initiatives to concentrate their efforts on promoting healthy diets. Healthy diets are based on human health and a sustainable environment. Such initiatives would result in a decrease of nutrition-related NCDs. As it is extremely challenging to reduce obesity rates on a national level, a recommendation for the prevention of obesity rates in Kyrgyzstan is highly encouraged before it reaches the levels of other LMICs.

This study contributed to the limited knowledge of nutrition transition in Kyrgyzstan. It further gives a clear picture of diets' of women of reproductive age in underprivileged locations. Although westernisation of diets taking place in LMICs, traditional food is a vital part of diet. Urbanisation, economic growth, rise of NCDs indicate to the transformation of food culture which is occurring in Kyrgyzstan. Regardless of these developments, triple burden of malnutrition remains a serious problem in the society. Hidden hunger might cause morbidities in the long-term among adults. Concentration on energy-poor and nutrient dense foods is an important step towards insuring healthy diets. Additionally, diets should include locally available and seasonal foods, reduce environmental burden during production, transportation, and consumption. Future research should explore strategies for individuals' actions to healthy diet and development of national policies incentivizing consumption of healthy foods. Policies promoting healthy diets should be prioritized on the national policy agenda.

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# Annexes

## Annex 1. Supplementary materials for Chapter 2

### Online Supplementary Materials

1. Right after becoming independent, Kyrgyzstan experienced a rapid decline in economic growth. However, data below in table 1 shows that energy extracted from fat is quite high, almost 30%. This is mostly due to the Soviet's food policy which promoted dense energy products such as meat and milk through subsidizing them.

Table S1. Dietary intake categorized by age (1993) [Source 1]

| Age Group    | Energy (kcal) | % of Energy RDA | Protein Grams | % of Protein RDA | % Energy From Protein | % Energy From Fat |
|--------------|---------------|-----------------|---------------|------------------|-----------------------|-------------------|
| 18-29        | 2,207         | 90.7            | 70            | 149.5            | 12.7                  | 29.5              |
| 30-39        | 2,269         | 91.7            | 74            | 148.1            | 13.0                  | 31.3              |
| 40-49        | 2,146         | 85.4            | 72            | 135.7            | 13.3                  | 31.5              |
| 50-59        | 2,145         | 81.8            | 71            | 131.8            | 13.3                  | 30.1              |
| Total adults | 2,204         | 88.9            | 72            | 144.4            | 13.0                  | 30.4              |

2. The theory of nutrition transition states that demographic change influences diets as well. The population of Kyrgyzstan increased during the period 1990-2018 from 4.4mln to 6.2 mln.

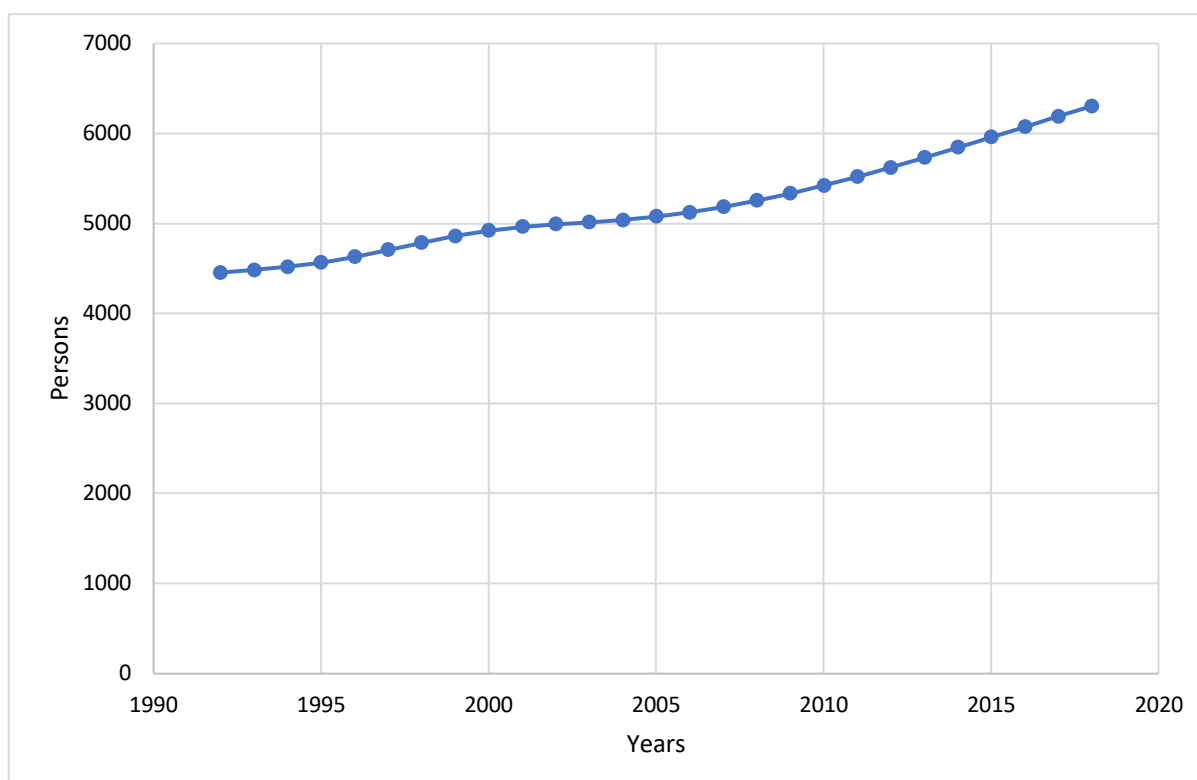


Figure S1. Total population of Kyrgyzstan for 1990-2018 (1000 persons) [Source 2]

3. Most food groups' supply increased. Open market economy diversifies food.

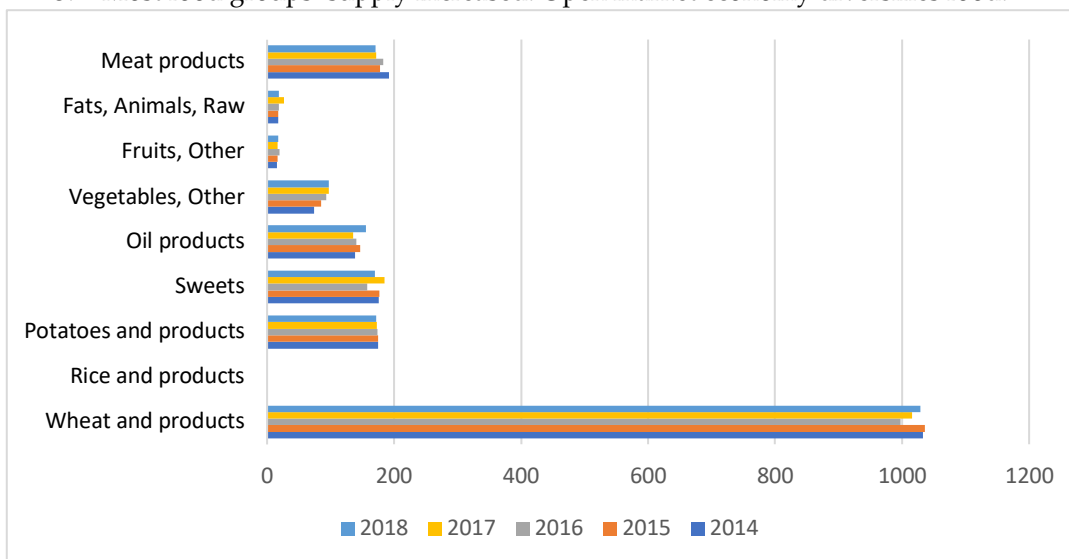


Figure S2. Food balances for major food groups (kcal/capita/day) [Source 3]

4. As the figure below shows, child mortality decreased during Soviet Union times in Kyrgyzstan.

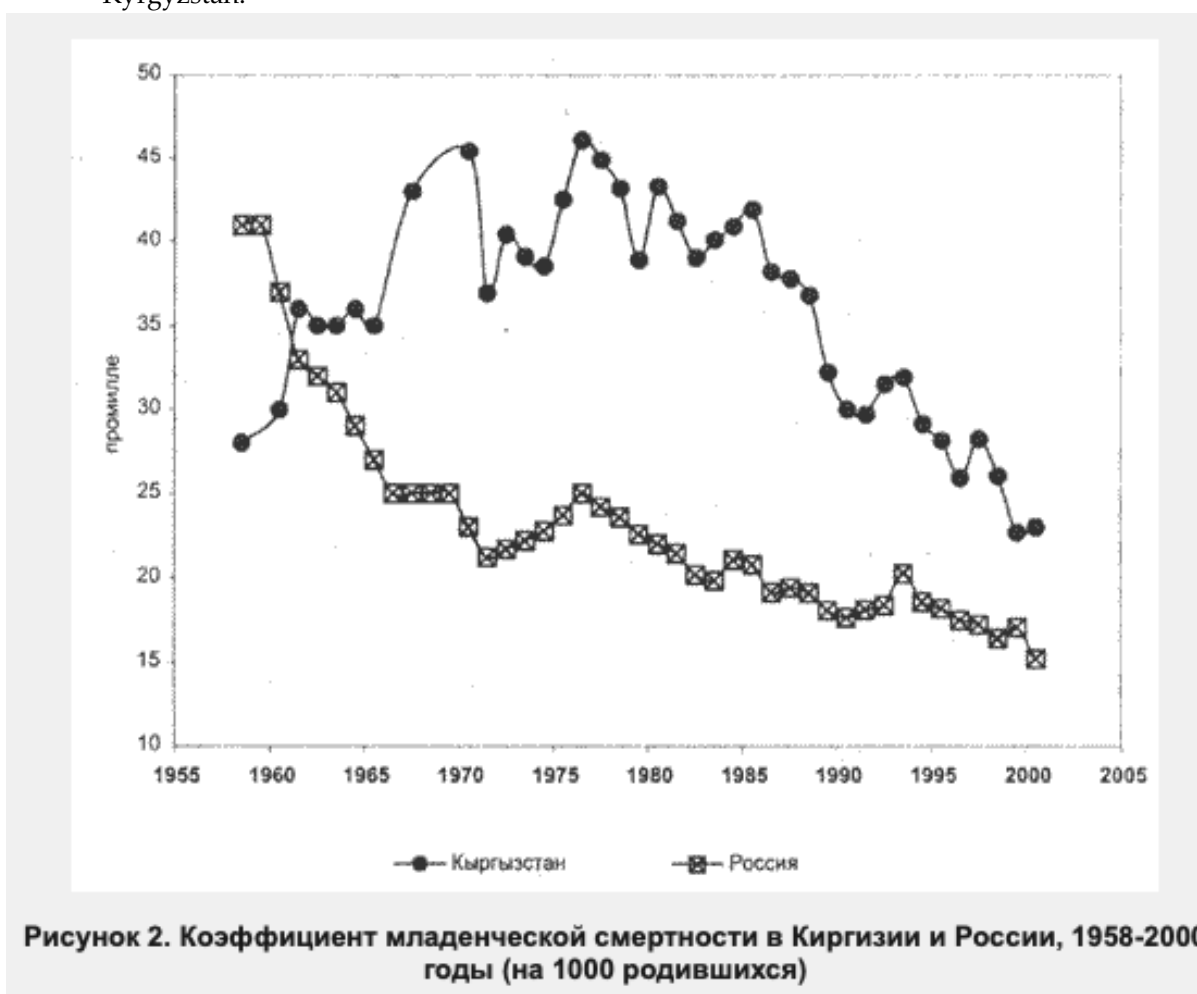


Рисунок 2. Коэффициент младенческой смертности в Киргизии и России, 1958-2000 годы (на 1000 родившихся)

Figure S3. Coefficient of child mortality in Kyrgyzstan and Russia for years 1958-2000 (for 1000 newborns)[Source 4]

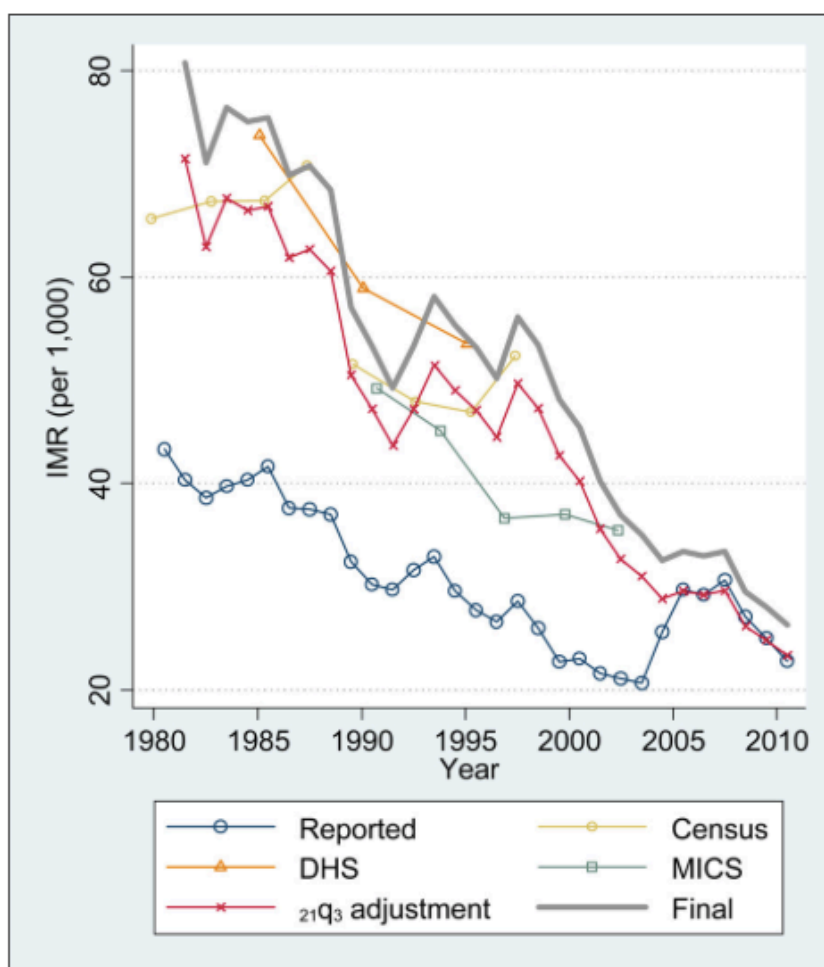
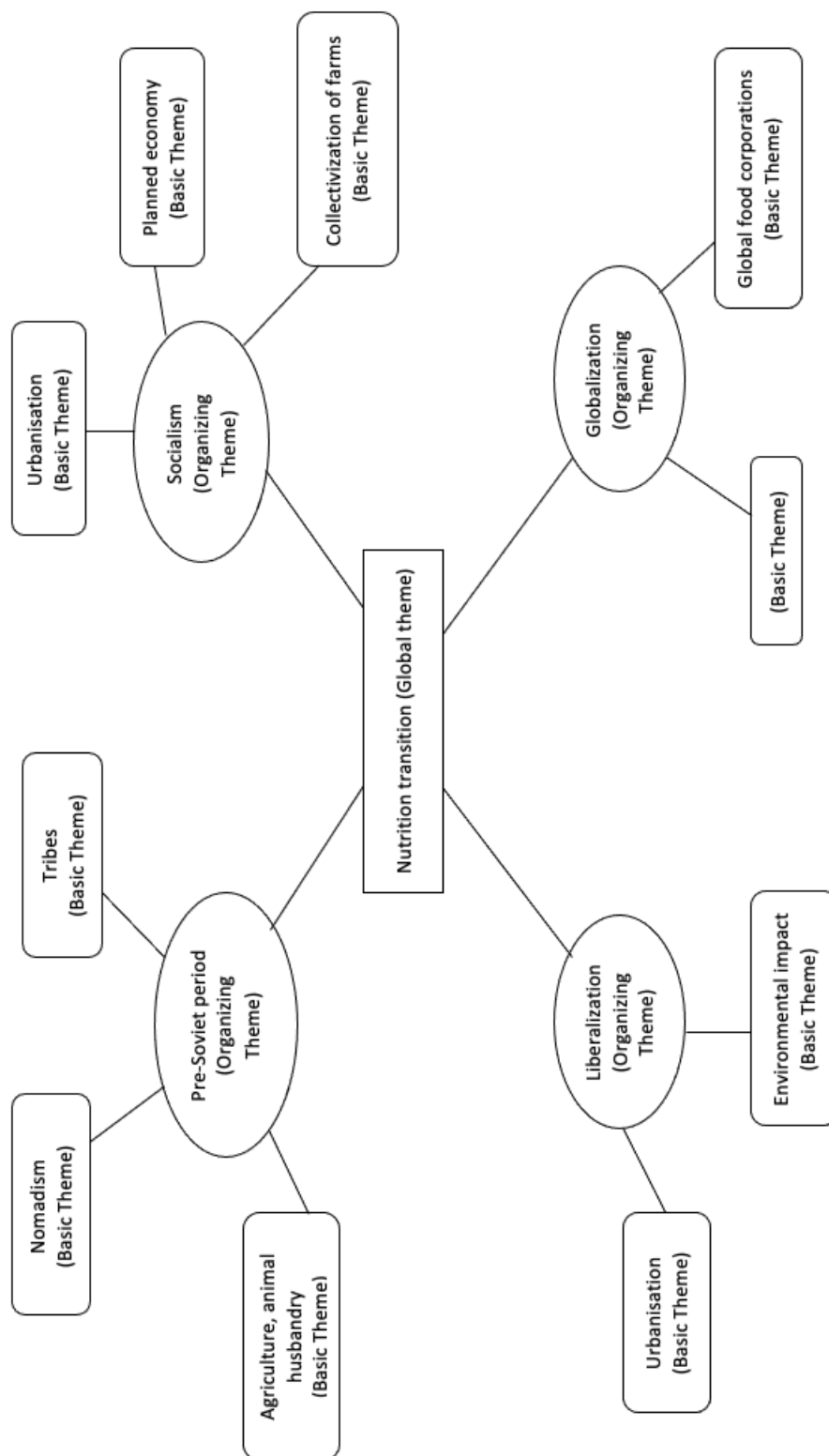


Figure S4. Infant mortality rate estimates 1980-2010 (various methods of calculation)  
[Source 4]

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Annex 2. Supplementary material for Chapter 2  
 Thematic network analysis (Attride-Stirling, 2001)



### Annex 3. Supplementary material for Chapter 3

Kendall correlation tau was employed to analyse correlation for categorical and continuous variables: DDS and socioeconomic and nutritional factors (age, education, family income, BMI level) (Table S1) as well as Wilcoxon test to compare continuous variables within groups (DDS with residence: rural/urban, region: North/South, remittances: yes/no, ethnicity: Kyrgyz/non-Kyrgyz, kitchen garden-cropland: yes/no, farm animals: yes/no, children: yes/no, farm harvest purpose: mostly sell/mostly self-consume, store distance: more than 2km/less than 2km) and found that some variables have no correlation and differences. Those variables which are statistically significant were included to the body of the article. DDS has no correlation and is statistically insignificant with age, level of education, family income and BMI level (Table S1). DDS is not different among women receiving remittances and not receiving remittances, among Kyrgyz and non-Kyrgyz, among those who have children and who do not have one, among those who mostly sell their harvest and those who mostly consume themselves, and those who live close to the food market and those who live far from it (Table S2).

**Table S1.** Socioeconomic and demographic variables and DDS (Kendall tau correlation).

| Variables      | DDS<br>tau    | <i>p</i> | Adjusted <i>p</i> |
|----------------|---------------|----------|-------------------|
| Age:           | 0.04997285    | 0.222    | 0.8880000         |
| Education:     | -0.01829489   | 0.6535   | 0.9414667         |
| Family income: | 0.01482655    | 0.7061   | 0.9414667         |
| BMI level:     | -0.0008414101 | 0.9816   | 0.9816000         |

DDS –

dietary diversity score

**Table S2.** Socioeconomic and demographic variables and DDS (Mann Whitney U test)

| Variables                  | DDS<br>Cles, rbsc, pseudomedian, 95% CI low,<br>95% CI high, <i>p</i> -value           | Adjusted <i>p</i> -value |
|----------------------------|--|--------------------------|
| Residence<br>(Rural/urban) | 0.3307487,<br>-0.3385026, 0.999959, 2.228878e-05,<br>1.000043e+00,<br>1.368e-07*       | 0.0000012312**           |
| Region (South/North)       | 0.6132317, 0.2264635,<br>-3.735724e-05,<br>-9.999299e-01,<br>-1.496737e-05, 0.01431*   | 0.0321975000**           |
| Remittances                | 0.491244,<br>-0.01751193, 5.27875e-05,<br>-4.678887e-05, 4.663804e-05, 0.3411          | 0.4385571429             |
| Ethnicity                  | 0.4716438,<br>-0.05671233,<br>-2.005951e-05,<br>-5.213814e-05, 3.624930e-05,<br>0.4389 | 0.4937625000             |
| Kitchen garden             | 0.5986375, 0.1972751,<br>-0.999971,<br>-9.999430e-01,                                  | 0.0011749500**           |

|                           |   |                |
|---------------------------|---|----------------|
|                           | -4.461354e-05, 0.0002611*   |                |
| Farm animals              | 0.598561, 0.1971219,<br>-4.22736e-05,<br>-9.999390e-01,<br>-4.672716e-05, 0.003102* | 0.0093060000** |
| Children                  | 0.5688372, 0.1376743, -5.093497e-05, -<br>5.526166e-05, 7.103729e-05, 0.1968        | 0.2952000000   |
| Harvest animal<br>purpose | 0.5610867, 0.1221734, -9.703766e-05, -<br>9.999339e-01, 3.130242e-05, 0.4965        | 0.4965000000   |
| Store distance            | 0.5528687, 0.1057375, -2.868532e-06, -<br>0.9999854204, 0.0000538829, 0.1809        | 0.2952000000   |

DDS – dietary diversity score; Cles – common language effect size; rbsc – rank-biserial correlation

The Kendall tau correlation was employed for continuous and categorical variables (nutrient adequacy ratios for different macro- and micronutrient variables): income, education, and BMI (Table S3). The Results section of the article contains details of findings regarding this table with a figure.

**Table S3.** Relationships between NAR for macro-and micronutrients and some socioeconomic indicators.

| Variables         | Income                      |         |                  | Education                   |         |                  | BMI                         |         |                  |
|-------------------|-----------------------------|---------|------------------|-----------------------------|---------|------------------|-----------------------------|---------|------------------|
|                   | Kendall's correlation (tau) | p-value | adjusted p-value | Kendall's correlation (tau) | p-value | adjusted p-value | Kendall's correlation (tau) | p-value | adjusted p-value |
| NAR energy        | -0.053                      | 0.146   | 0.310            | -0.119                      | 0.001*  | 0.006**          | 0.03                        | 0.376   | 0.436            |
| NAR protein       | -0.045                      | 0.216   | 0.4003           | -0.048                      | 0.204   | 0.247            | 0.019                       | 0.556   | 0.590            |
| NAR fat           | 0.017                       | 0.644   | 0.684            | -0.0305                     | 0.416   | 0.442            | -0.004                      | 0.894   | 0.892            |
| NAR carbohydrates | -0.075                      | 0.037*  | 0.152            | -0.138                      | 0.0002* | 0.001**          | 0.050                       | 0.125   | 0.255            |
| NAR fibre         | -0.133                      | 0.0002* | 0.003**          | -0.170                      | 0.059*  | 0.0001**         | 0.094                       | 0.003*  | 0.080            |
| NAR Vit. A        | -0.043                      | 0.235   | 0.4003           | -0.065                      | 0.084   | 0.129            | 0.049                       | 0.128   | 0.255            |
| NAR Vit E.        | 0.006                       | 0.871   | 0.871            | -0.073                      | 0.050*  | 0.085            | 0.057                       | 0.082   | 0.255            |
| NAR Vit B1        | -0.076                      | 0.044*  | 0.152            | -0.104                      | 0.008*  | 0.016**          | 0.042                       | 0.222   | 0.314            |



|               |         |        |         |        |        |          |       |       |       |
|---------------|---------|--------|---------|--------|--------|----------|-------|-------|-------|
| NAR Vit B2    | -0.037  | 0.319  | 0.494   | -0.053 | 0.173  | 0.244    | 0.024 | 0.478 | 0.541 |
| NAR Vit B6    | -0.017  | 0.643  | 0.684   | -0.049 | 0.204  | 0.247    | 0.045 | 0.182 | 0.309 |
| NAR fol. acid | -0.113  | 0.001* | 0.015** | -0.153 | 0.047* | >0.001** | 0.058 | 0.078 | 0.255 |
| NAR Vit. C    | 0.018   | 0.615  | 0.684   | -0.018 | 0.622  | 0.622    | 0.033 | 0.314 | 0.411 |
| NAR calcium   | -0.031  | 0.392  | 0.512   | -0.075 | 0.046* | 0.085    | 0.049 | 0.135 | 0.255 |
| NAR magnesium | -0.075* | 0.038* | 0.152   | -0.102 | 0.007* | 0.016**  | 0.055 | 0.094 | 0.255 |
| NAR iron      | -0.059  | 0.107  | 0.272   | -0.113 | 0.002* | 0.008**  | 0.053 | 0.108 | 0.255 |
| NAR zink      | -0.034  | 0.349  | 0.494   | -0.041 | 0.272  | 0.308    | 0.040 | 0.215 | 0.314 |
| MAR 16        | -0.058  | 0.112  | 0.272   | -0.111 | 0.003* | 0.008**  | 0.063 | 0.054 | 0.255 |

NAR – nutrient adequacy ratio; Mar 16 – mean adequacy ratio; \*p-value < 0.05; \*\*adjusted p-value < 0.05.

Mann Whitney U test is used to continuous and binary variables: NARs for macro- and micronutrients and residence: rural/urban, kitchen garden-cropland: yes/no, harvest animal purpose: mostly sell/mostly self-consume, store distance: less than 2km/more than 2km, remittances: yes/no, farm animal: yes/no (Table S4). Results are discussed in the Results section of the paper.

**Table S4.** Factors determining diet adequacy.

| Variables   | Residence      | Kitchen garden/cropland | Harvest animal purpose | Store distance | Remittances    | Farm animal    |
|---|----------------|-------------------------|------------------------|----------------|----------------|----------------|
| <b>Cles, rbcs, pseudomedian, 95% CI low, 95% CI high, p-value, p value adjusted</b> |                |                         |                        |                |                |                |
| NAR energy  | 0.4178735,     | 0.4297417,              | 0.4608166,             | 0.564182,      | 0.5555778,     | 0.5822907,     |
|   | -0.1642529,    | -0.1405166,             | -0.07836685,           | 0.128364,      | 0.1111555,     | 0.1645814,     |
|   | 0.08002865,    | 0.07003125,             | 0.03000906,            | -0.06004081,   | -0.06006198,   | -0.08003687,   |
|   | 0.02992904,    | 0.02004382,             | -0.04003885,           | -0.14992098,   | -0.1299710768, | -0.13998215,   |
|   | 0.13995894,    | 0.12996596,             | 0.10998086,            | 0.02997664,    | 0.0000719134,  | -0.03000136,   |
|   | 0.002504*      | 0.006965*               | 0.367                  | 0.1775         | 0.06681        | 0.002615*      |
|   | 1.064200e-02** | 0.029601250**           | 0.7798750              | 0.2953750      | 0.14197125     | 0.0148183333** |
| NAR protein   | 0.5379089,     | 0.4826845,              | 0.4397473,             | 0.5883583,     | 0.5424521,     | 0.5189268,     |
|   | 0.07581789,    | -0.03463097,            | -0.1205054,            | 0.1767165,     | 0.08490415,    | 0.03785353,    |
|   | -0.03000421,   | 0.02003718,             | 0.0599629,             | -0.08000158,   | -0.07994904,   | -0.03001758,   |
|   | -0.10996923,   | -0.04995318,            | -0.04001165,           | -0.19000683,   | -0.16001741,   | -0.10002434    |
|   | 0.04996492,    | 0.09998156, 0.5131      | 0.15998980,            | 0.030005915,   | 0.01008866,    | 0.04001866,    |
|   | 0.4502         | 0.670976923             | 0.2667                 | 0.1638         | 0.08552        | 0.4013         |
|   | 6.951692e-01   |                         | 0.7556500              | 0.2953750      | 0.16153778     | 0.5685083333   |

|                  |                |                    |                |                |                |                |
|------------------|----------------|--------------------|----------------|----------------|----------------|----------------|
| NAR fat          | 0.482819,      | 0.4972932,         | 0.4601262,     | 0.5729579,     | 0.5157661,     | 0.4941409,     |
|                  | -0.03436201,   | -0.005413541,      | -0.0797475,    | 0.1459158,     | 0.03153213,    | -0.01171811,   |
|                  | 0.02995502,    | 0.009970382,       | 0.05002971,    | -0.1099964,    | -0.03997604,   | 0.01998628,    |
|                  | -0.05999925,   | -0.07007149,       | -0.06004967,   | -0.230070458,  | -0.13002569,   | -0.06998256    |
|                  | 0.10000954,    | 0.08998467, 0.8438 | 0.15996399,    | 0.009936597,   | 0.05997462,    | 0.09004553,    |
|                  | 0.5262         | 0.896537500        | 0.3622         | 0.06188        | 0.4232         | 0.7167         |
|                  | 6.951692e-01   |                    | 0.7798750      | 0.2953750      | 0.51388571     | 0.8905571429   |
| NAR carbohydrate | 0.3670179,     | 0.3921873,         | 0.4850633,     | 0.5230399,     | 0.5666272,     | 0.6322409,     |
|                  | -0.2659642,    | -0.2156254,        | -0.02987346,   | 0.04607982,    | 0.1332544,     | 0.2644819,     |
|                  | 0.1299165,     | 0.09999568,        | 0.009969848,   | -0.02999155,   | -0.06994448,   | -0.1299886,    |
|                  | 0.07994871,    | 0.04997043,        | -0.07005244,   | -0.12993219,   | -1.399870e-01, | -0.18998193    |
|                  | 0.18001836,    | 0.15995385,        | 0.08002656,    | 0.06993472,    | -7.063806e-05, | -0.07000424,   |
|                  | 3.743e-06*     | 0.0003443*         | 0.8737         | 0.5597         | 0.04013*       | 7.401e-06      |
|                  | 3.181550e-05** | 0.002926550**      | 0.9283062      | 0.6343267      | 0.09903714     | 0.0000629085** |
| NAR fibre        | 0.3783776,     | 0.3936846,         | 0.4728676,     | 0.5191042,     | 0.5748546,     | 0.6305862,     |
|                  | -0.2432448,    | -0.2126307,        | -0.05426489,   | 0.03820835,    | 0.1497092,     | 0.2611723,     |
|                  | 0.1500047,     | 0.1399684,         | 0.01003457,    | -7.792522e-06, | -0.09006704,   | -0.170049,     |
|                  | 0.08993393,    | 0.0700439,         | -0.08003811,   | -0.1199429,    | -0.17001565    | -0.2400624     |
|                  | 0.21994411,    | 0.2000470, 5.859e- | 0.10995617,    | 0.1100440,     | -0.01006266,   | -0.1099793,    |
|                  | 8.539e-06      | 05                 | 0.7823         | 0.9674         | 0.02169*       | 8.956e-07      |
|                  | 4.838767e-05** | 0.000996030**      | 0.9283062      | 0.9704000      | 0.08785600     | 0.0000152252** |
| NAR Vit. A       | 0.4701644,     | 0.4718786,         | 0.4813813,     | 0.5131686,     | 0.4906194,     | 0.5268961,     |
|                  | -0.05967114,   | -0.05624288,       | -0.0372374,    | 0.02633715,    | -0.01876112,   | 0.05379226,    |
|                  | 0.0199919,     | 0.0399634,         | 0.1200573,     | 4.334691e-05,  | -0.029949,     | 3.208944e-06,  |
|                  | -0.07993667,   | -0.06000363,       | -0.02005334,   | -0.1500727,    | -0.15008539,   | -0.1099184     |
|                  | 0.12005190,    | 0.13997703,        | 0.28000108,    | 0.1699653,     | 0.09999701,    | 0.1000354,     |
|                  | 0.6934         | 0.4632             | 0.1056         | 0.9704         | 0.6653         | 0.9698         |
|                  | 8.419857e-01   | 0.656200000        | 0.7556500      | 0.9704000      | 0.73631250     | 0.9698000000   |
| NAR Vit E.       | 0.5388153,     | 0.5291968,         | 0.4906868,     | 0.5746354,     | 0.4888186,     | 0.4593301,     |
|                  | 0.07763066,    | 0.0583935,         | -0.01862632,   | 0.1492709,     | -0.02236272,   | -0.08133985,   |
|                  | -0.05993001,   | -0.01995276,       | 0.03007947,    | -0.07001299,   | -0.00996704,   | 0.05997089,    |
|                  | -0.14996093,   | -0.10992268,       | -0.07002139,   | -0.20997791    | -0.10000257    | -0.02001871    |
|                  | 0.02999586,    | 0.06000014, 0.6326 | 0.13997085,    | 0.04997141,    | 0.09005944,    | 0.14001980,    |
|                  | 0.1875         | 0.768157143        | 0.5584         | 0.2085         | 0.8957         | 0.1639         |
|                  | 3.541667e-01** |                    | 0.9283062      | 0.2953750      | 0.89570000     | 0.3095888889   |
| NAR Vit B1       | 0.4722096,     | 0.4638614,         | 0.4567277,     | 0.5899683,     | 0.5654107,     | 0.5259195,     |
|                  | -0.05558084,   | -0.07227722,       | -0.08654454,   | 0.1799366,     | 0.1308213,     | 0.05183891,    |
|                  | 3.668929e-05,  | 0.05995351,        | 5.650447e-05,  | -8.015769e-05, | -0.06004653,   | -5.620605e-06, |
|                  | -6.512014e-05, | 2.982409e-05,      | -0.0000328337, | -0.0700266073, | -7.001561e-02, | -6.998033e-02  |
|                  | 6.992468e-02,  | 6.998800e-02,      | 0.0600211387,  | 0.0000330382,  | -5.006409e-05, | 5.826962e-06,  |
|                  | 0.09382        | 0.01321*           | 0.6732         | 0.1754         | 0.007304*      | 0.1205         |
|                  | 2.278486e-01** | 0.044914000**      | 0.9283062      | 0.2953750      | 0.08785600     | 0.2560625000   |
| NAR Vit B2       | 0.4926454,     | 0.469201,          | 0.5220457,     | 0.6090998,     | 0.5385477,     | 0.513593,      |
|                  | -0.0147092,    | -0.06159806,       | 0.04409141,    | 0.2181996,     | 0.07709533,    | 0.0271859,     |
|                  | -1.010764e-05, | 2.81072e-05,       | 3.779491e-05,  | -0.05993355,   | -0.04996032,   | -1.444069e-05, |
|                  | -0.04998924,   | -2.021424e-05,     | -0.04996107,   | -1.099534e-01, | -5.998548e-02  | -0.04996620    |
|                  | 0.04997835,    | 5.002721e-02,      | 0.05000760,    | -4.770645e-05, | 3.271315e-05,  | 0.04997417,    |
|                  | 0.8735         | 0.3797             | 0.7773         | 0.02075*       | 0.09897        | 0.9202         |
|                  | 9.280938e-01   | 0.586809091        | 0.9283062      | 0.2299250      | 0.16824900     | 0.9698000000   |

|                |               |                    |                |                |                |                |
|----------------|---------------|--------------------|----------------|----------------|----------------|----------------|
| NAR Vit B6     | 0.5067021,    | 0.481279,          | 0.4723258,     | 0.6211364,     | 0.518163,      | 0.5176403,     |
|                | 0.01340424,   | -0.03744196,       | -0.05534843,   | 0.2422728,     | 0.03632607,    | 0.0352805,     |
|                | 3.238713e-05, | 3.977365e-05,      | 9.286e-06, -   | -0.05004067,   | -3.577752e-05, | -4.035236e-05, |
|                | -0.04997802,  | -6.096123e-06,     | 0.04998214,    | -1.000311e-01, | -5.001774e-02  | -5.002502e-02  |
|                | 0.049964600,  | 5.002696e-02,      | 0.05006314,    | -7.145601e-05, | 1.883423e-05,  | 6.566271e-05,  |
|                | 0.9283        | 0.3011             | 0.8527         | 0.02705*       | 0.3214         | 0.3823         |
| 9.283000e-01   | 0.511870000   | 0.9283062          | 0.2299250      | 0.45531667     | 0.5685083333   |                |
| NAR fol. acid  | 0.4291592,    | 0.456799,          | 0.5740547,     | 0.5773688,     | 0.5688198,     | 0.5383022,     |
|                | -0.1416815,   | -0.08640206,       | 0.1481093,     | 0.1547375,     | 0.1376396,     | 0.07660434,    |
|                | 0.3949441,    | 0.04993223,        | -0.03995732,   | -0.03001781,   | -0.04996832,   | -0.04000553,   |
|                | 0.3749520,    | 0.01996194,        | -7.996184e-02, | -0.07993603,   | -0.080008068,  | -0.07003246    |
|                | 0.4150419,    | 0.07997687,        | 1.224565e-05,  | 0.01998416,    | -0.009999027,  | -0.01002450,   |
|                | 2.2e-16*      | 0.001546*          | 0.07847        | 0.2038         | 0.01591*       | 0.006049*      |
| 3.740000e-15** | 0.008760667** | 0.7556500          | 0.2953750      | 0.08785600     | 0.0257082500** |                |
| NAR Vit. C     | 0.5172243,    | 0.5136736,         | 0.4695681,     | 0.568728,      | 0.5350799,     | 0.4919568,     |
|                | 0.03444858,   | 0.02734716,        | -0.06086374,   | 0.137456,      | 0.07015974,    | -0.01608646,   |
|                | -0.009958969, | 4.266827e-05,      | -2.387871e-05, | -0.05005258,   | -0.01004382,   | 1.070791e-06,  |
|                | -0.05997019,  | -0.05004070,       | -0.07991099    | -0.14006239,   | -0.07991553,   | -0.05996945    |
|                | 0.04999773,   | 0.05993263,        | 0.07003053,    | 0.02998933,    | 0.05000550,    | 0.05000863,    |
|                | 0.8386        | 0.9353             | 0.9667         | 0.1906         | 0.693          | 0.9624         |
| 9.280938e-01   | 0.935300000   | 0.9667000          | 0.2953750      | 0.73631250     | 0.9698000000   |                |
| NAR calcium    | 0.4309787,    | 0.4585224,         | 0.5592598,     | 0.5663869,     | 0.5154893,     | 0.5261117,     |
|                | -0.1380425,   | -0.08295526,       | 0.1185196,     | 0.1327737,     | 0.03097866,    | 0.05222343,    |
|                | 0.02993532,   | 0.01997549, -      | -0.0100365,    | -0.02002771,   | -0.01003646,   | -0.0100152,    |
|                | 1.094691e-05, | 1.734711e-05,      | -0.04002861,   | -0.05995206,   | -0.03996898,   | -0.03999229    |
|                | 4.997193e-02, | 4.004132e-02,      | 0.01999683,    | 0.01004624,    | 0.01991966,    | 0.01004212,    |
|                | 0.02626*      | 0.1134             | 0.4376         | 0.2311         | 0.423          | 0.2919         |
| 8.928400e-02   | 0.214200000   | 0.8265778          | 0.3022077      | 0.51388571     | 0.4962300000   |                |
| NAR magnesium  | 0.4527854,    | 0.4560631,         | 0.5302609,     | 0.6083082,     | 0.5515902,     | 0.5429556,     |
|                | -0.09442921,  | -0.08787387,       | 0.06052178,    | 0.2166163,     | 0.1031803,     | 0.08591115,    |
|                | 0.03999853,   | 0.03994473,        | -7.887231e-06, | -0.04005839,   | -0.03001889,   | -0.03003839,   |
|                | 5.315912e-05, | 1.012004e-05,      | -0.04001535,   | -9.998112e-02, | -0.07002896    | -6.993784e-02  |
|                | 7.005021e-02, | 7.004725e-02,      | 0.03999851,    | 3.650134e-05,  | 0.01006845,    | 6.299116e-05,  |
|                | 0.04368*      | 0.03067*           | 0.8719         | 0.07915        | 0.1383         | 0.05326        |
| 1.237600e-01** | 0.086898333   | 0.9283062          | 0.2953750      | 0.21373636     | 0.1810840000   |                |
| NAR iron       | 0.4903699,    | 0.4576825,         | 0.4554134,     | 0.5931251,     | 0.5633498,     | 0.5403565,     |
|                | -0.0192602,   | -0.08463494,       | -0.08917315,   | 0.1862501,     | 0.1266995,     | 0.08071305,    |
|                | 0.01002895,   | 0.04003451,        | 0.03004174,    | -0.04997049,   | -0.06000465,   | -0.0300369,    |
|                | -0.02992368,  | -5.831504e-05,     | -0.02006113,   | -0.10998998,   | -0.11002263,   | -0.079966159   |
|                | 0.05999170,   | 8.001718e-02,      | 0.08999049,    | 0.01002239,    | -0.01002358,   | 0.009996825,   |
|                | 0.5316        | 0.06106            | 0.2458         | 0.13,          | 0.01575*       | 0.1079         |
| 6.951692e-01   | 0.129752500   | 0.7556500          | 0.2953750      | 0.08785600     | 0.2560625000   |                |
| NAR zink       | 0.5590078,    | 0.4952984,         | 0.4357427,     | 0.5777312,     | 0.5514442,     | 0.5009113,     |
|                | 0.1180155,    | -0.009403167,      | -0.1285146,    | 0.1554624,     | 0.1028885,     | 0.001822621,   |
|                | -0.04999226,  | 0.01004748,        | 0.04995845,    | -0.05002858,   | -0.08999031,   | -0.01003949,   |
|                | -0.1200016,   | -0.05995692,       | -0.03001893,   | -0.15996314,   | -0.16003969,   | -0.07994275    |
|                | 0.0200065,    | 0.07999270, 0.7207 | 0.13999303,    | 0.04998168,    | -0.01007552,   | 0.05998439,    |
|                | 0.168         | 0.816793333        | 0.2477         | 0.3187         | 0.02584*       | 0.7334         |
| 3.541667e-01** |               | 0.7556500          | 0.3869929      | 0.08785600     | 0.8905571429   |                |
| MAR 16         | 0.4699761,    | 0.459366,          | 0.4653376,     | 0.5918606,     | 0.5481874,     | 0.5412512,     |
|                |               |                    |                | 0.1837213,     | 0.09637477,    | 0.08250239,    |

|                |              |              |               |                |               |
|----------------|--------------|--------------|---------------|----------------|---------------|
| -0.06004777,   | -0.08126807, | -0.06932484, | -0.05003699,  | -0.05002088,   | -0.04004113,  |
| 0.02996721,    | 0.04004667,  | 0.03995661,  | -0.120067213, | -1.099926e-01, | -8.006802e-02 |
| -0.01996689,   | 7.53816e-05, | -0.01993707, | 0.009959691,  | -1.045352e-05, | 7.885911e-06, |
| 0.06996626,    | 8.99641e-02, | 0.09008634,  | 0.08688       | 0.04078*       | 0.07299       |
| 0.2542         | 0.04499*     | 0.2086       | 0.2953750     | 0.09903714     | 0.2068050000  |
| 4.321400e-01** | 0.109261429  | 0.7556500    |               |                |               |

NAR – nutrient adequacy ratio; Mar 16 – mean adequacy ratio; Cles – common language effect size; rbcs – rank-biserial correlation; \*p-value < 0.05; \*\*adjusted p-value < 0.05.

Annex 4. Ethical approval

|  |  |
|--|--|
| <p>КЫРГЫЗ РЕСПУБЛИКАСЫНЫН<br/>БИЛИМ БЕРҮҮ ЖАНА ИЛИМ МИНИСТРЛИГИ</p> <p><b>И. РАЗЗАКОВ атындагы КЫРГЫЗ<br/>МАМЛЕКЕТТИК ТЕХНИКАЛЫК<br/>УНИВЕРСИТЕТИ</b></p> <p>720044, Кыргызстан, Бишкек ш.<br/>Ч.Айтматов к., 66<br/>Тел. +996 312 545125, факс +996 312 545162</p> <p>Первомайский РОК р/с 4402011103004532 Центральное Казначейство при МФКР НБКР<br/>БИК 440001 ИНН 02702200610350 Код ОКПО 23999934<br/>УГНС Первомайского района 004</p> <p>2399993 4</p> | <p>МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ<br/>КЫРГЫЗСКОЙ РЕСПУБЛИКИ</p> <p><b>КЫРГЫЗСКИЙ ГОСУДАРСТВЕННЫЙ<br/>ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ<br/>им. И. РАЗЗАКОВА</b></p> <p>720044, Кыргызстан, г. Бишкек,<br/>пр. Ч.Айтматова, 66<br/>E-mail: <a href="mailto:rector@kstu.kg">rector@kstu.kg</a> Website: <a href="http://kstu.kg">http://kstu.kg</a></p> <p>0253101 2</p> |
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№ 370/01-2  
« 19 » 03 2021-ж.  
№ \_\_\_\_\_

Ethical Clearance for the research "Dietary diversity of women of reproductive age in Kyrgyzstan: Understanding their knowledge, attitudes and practices related to nutrition"

The Ethical Review Committee (ERC) of the Kyrgyz State Technical University named after I.Razzakov reviewed the application for the above titled study led by Dr. Jamila Smanalieva from Department "Food Productions Technology" and PhD Students of Faculty of Organic Agricultural Sciences of University Kassel (Germany) Ms. Aiperi Otunchieva. Based on recommendations from the reviewers the ERC decided to approve the referenced protocol subject. The researchers may commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the ERC must be informed immediately of:


- Any material changes in the conditions or undertakings mentioned in the document
- Any material breaches of ethical undertakings or events that may impact upon the ethical conduct of the research

The researcher must report to the ERC in the prescribed format at the end of the project in respect of ethical compliance.

The ERC retains the right to:

- Withdraw or amend this Ethical clearance Certificate if:
  1. Any unethical principal or practices are revealed or suspected
  2. Relevant information has been withheld or misrepresented
  3. The conditions contained in the Certificate have not been adhered to.
- Request access to any information or data at any time during the course or after completion of the project.

Vice-Rector for Academic Affairs



004839

## Annex 5. Questionnaire in English and Russian

Dear respondent,

This questionnaire is intended for collecting information regarding the diet quality of women of reproductive age of 18-49 age who live in Kyrgyzstan.

I, Aiperi Otunchieva, a student studying in PhD Program in the Faculty of Organic Agricultural Sciences, hereby state that the work contained in this questionnaire is aimed merely for finishing my study.

All respondents will stay anonymous (names will not be published). All of the content of information is going to be used solely for finishing my article with the title:

**Study of micronutrient deficiency through analysis of diet diversity among women of reproductive age 18-49 years old**

I would be grateful if you devote 40 min of your time to respond my questions regarding your diet.

Thank you very much for answering these questions. I express my sincere gratitude for your time and patience.

Sincerely yours,  
Aiperi Otunchieva

### A. Profile of a respondent

1. Name \_\_\_\_\_

2. Where do you live:

- a. At Bashy
- b. Aravan
- c. Bishkek city
- d. Osh city

3. Phone number \_\_\_\_\_

4. Can we call you in case of need for clarification?      Yes      No

5. Age

- a. 18-27
- b. 28-39
- c. 40-49

6. Ethnicity

- a. Kyrgyz
- b. Other \_\_\_\_\_

7. Education
- a. Primary education
  - b. Secondary education
  - c. Vocational school
  - d. Higher education

8. Your occupation
- a. Housewife
  - b. Employed
  - c. Entrepreneur
  - d. Student

9. Marital status
- a. Married
  - b. Divorced
  - c. Single
  - d. Other

10. Your weight (kg) \_\_\_\_\_ Your height (cm) \_\_\_\_\_

**B. Household**

11. Number of inhabitants in the household
- a. 4 or less
  - b. More than 4
- Of them children \_\_\_\_\_

12. Family income in KG soms per month
- a. 0-5,000
  - b. 5,001-10,000
  - c. 10,001-20,000
  - d. 20,001-30,000
  - e. 30,001-40,000
  - f. 40,001 and more

13. How much do you spend on food items in one month (KG soms)?
- a. 0-5,000
  - b. 5,001-10,000
  - c. 10,001-20,000
  - d. 20,001-30,000
  - e. 30,001-40,000
  - f. 40,001 and more

14. Has any of your household members migrated?
- a. Yes
  - b. No

15. Do you receive remittances through migration?

- a. Yes
- b. No

16. What is your main source of income?

- a. Agriculture
- b. Employment
- c. Private business
- d. Remittances

### **C. Farm**

17. What is the size of your cropland?

- a. I have no cropland
- b. Less than 1ha
- c. 1-2 ha
- d. 2-4 ha
- e. 4-10 ha
- f. More than 10ha

18. Do you have a kitchen garden?

- a. Yes
- b. No

19. Do you harvest anything?

- a. Yes
- b. No

If yes:

19a. What have you harvested in your cropland and/or kitchen garden in the last 12 months?

---

20. Do you have farm animals?

- a. Yes
- b. No

If yes:

20 a. Which farm animals have you been breeding in the last 12 months?

---

21. What percentage of food comes from your land?

- a. 0%
- b. Less than 50%
- c. More than 50%

22. What do you do with your harvest/farm animals?

- a. Mostly sell
- c. Mostly self-consume



23. How far away is the next grocery store from your house?

- a. 2km or less
- b. More than 2km

**D. 24-h diet recall**

| <b>Time</b>         | <b>List what was consumed</b> | <b>Ingredients</b> | <b>Portion: plate/soup cup/tea cup/spoon/tea spoon (use pictures)</b> | <b>Comments</b> |
|---------------------|-------------------------------|--------------------|---|-----------------|
| Breakfast:<br>Snack |                               |                    |   |                 |
| Lunch<br>Snack      |                               |                    |   |                 |
| Dinner<br>Snack     |                               |                    |   |                 |

After diet recall, ask whether a respondent consumed any items from the below-mentioned food groups:

|   | Food categories                             | Local food examples   | Yes = 1<br>No= 0 |
|---|---|---|------------------|
| A | Foods made from grains                      | Rice, Porridge, bread, noodles  |                  |
| B | White roots and tubers and plantains        | Potatoes, or any other foods made from white-fleshed roots or tubers, or plantains            |                  |
| C | Pulses (beans, peas and lentils)            | Mature beans or peas (fresh or dried seed), lentils or bean/pea products                      |                  |
| D | Nuts and seeds                              | Any tree nut (e.g. walnut), groundnut/peanut or certain seeds, or nuts                        |                  |
| E | Milk and milk Products                      | Milk, yoghurt or other milk products but NOT including butter, ice cream, cream or sour cream |                  |
| F | Organ meat                                  | Liver, kidney, heart or other organ meats or blood-based foods, including from wild           |                  |
| G | Meat and poultry                            | Beef, goat, wild meat, chicken, duck or other bird  |                  |
| H | Fish and seafood                            | Fresh or dried fish   |                  |
| I | Eggs  | Eggs from poultry   |                  |
| J | Dark green leafy vegetables                 | List examples of any medium-to-dark green leafy vegetables, including wild/foraged leaves     |                  |
| K | Vitamin A-rich vegetables, roots and tubers | Pumpkin, carrots, sweet rep pepper  |                  |
| L | Vitamin A-rich fruits                       | Apricots, watermelon, nectarine   |                  |
| M | Other vegetables                            | List examples of any other vegetables   |                  |
| N | Other fruits                                | List examples of any other fruits   |                  |

| O | Food categories            | Description and examples  | Yes = 1<br>No= 0 |
|---|----------------------------|---|------------------|
| Q | Oils and fat               | Oils: A fat or oil added to food or used for cooking, including butter extracted from nuts, fruits and seeds; and all animal fats                 |                  |
| R | Fried and not sweet snacks | Chips and chips, fried dough or other fried snacks  |                  |
| S | Sweets                     | Sugary foods such as chocolate, candy, cookies/sweet biscuits and cakes, sweet pastries or ice cream  |                  |
| T | Sugar-containing drinks    | Sweetened fruit juices and juice drinks, soft/carbonated drinks, chocolate drinks, malt drinks, yogurt drinks, or sweet tea or coffee with sugar. |                  |
| U | Condiments                 | Ingredients used in small quantities for flavoring, such as chili peppers, spices, herbs, fish powder, tomato paste, aromatic cubes or seeds.     |                  |
| V | Other drinks and foods     | Tea or coffee without sugar and other drinks: jarma, shoro, chalap, kymyz   |                  |

## ОПРОСНИК

Уважаемый респондент,

Анкета предназначена для сбора информации о качестве питания женщин репродуктивного возраста 18-49 лет, проживающих в Кыргызстане.

Мы, Д-р Жамила Сманалиева и Айпери Отунчиева, студентка аспирантуры факультета органических сельскохозяйственных наук, Кассельского Университета в Германии, настоящим заявляю, что работа, содержащаяся в этой анкете, предназначена только для завершения моей учебы.

Все респонденты останутся анонимными (имена не будут опубликованы). Все содержание информации будет использовано исключительно для завершения моей статьи заголовком:

Изучение дефицита микронутриентов на основе анализа разнообразия рациона женщин репродуктивного возраста 18-49 лет

Будем признательна, если вы посвятите 40 минут своего времени ответам на вопросы относительно своего питания.

Выражаем Вам искреннюю благодарность за Ваше время и сотрудничество.

Искренне Ваша,  
Айпери Отунчиева

### А. Профиль респондента

1. Имя \_\_\_\_\_

2. Где вы живете:

- а. Ат Башы
- б. Араван
- в. город Бишкек
- г. город Ош

3. Номер телефона \_\_\_\_\_

4. Можем ли мы позвонить вам в случае необходимости уточнения?

- а. Да
- б. Нет

5. Ваш возраст:

- а. 18-27
- б. 28-39
- в. 40-49

6. Ваша этническая принадлежность:

- а. Кыргызка

б. Другой

7. Образование:

- а. Начальное образование
- б. Среднее образование
- в. Профессиональная школа
- г. Высшее образование

8. Ваша профессия:

- а. Домохозяйка
- б. Наемный работник
- в. Предприниматель
- г. Студент

9. Семейное положение:

- а. Замужем
- б. В разводе
- в. Не замужем
- г. Другой \_\_\_\_\_

10. Ваш вес (кг) \_\_\_\_\_ Ваш рост (см) \_\_\_\_\_

**Б. Домашнее хозяйство**

11. Количество жителей в домохозяйстве

- а. 4 или меньше 4
- б. Больше 4

Из них дети \_\_\_\_\_

12. Доход семьи в сомах в месяц.

- а. 0–5 000
- б. 5 001–10 000
- с. 10 001–20 000
- д. 20 001–30 000
- е. 30 001–40 000
- ф. 40 001 и более

13. Сколько вы тратите на продукты питания в месяц (сомы)?

- а. 0–5 000
- б. 5 001–10 000
- с. 10 001–20 000
- д. 20 001–30 000
- е. 30 001–40 000
- ф. 40 001 и более

14. Мигрировал ли кто-нибудь из членов вашей семьи?

- а. да

б. Нет

15. Получаете ли вы денежные переводы в результате миграции?

а. да

б. Нет

16. Каков ваш основной источник дохода?

а. сельское хозяйство

б. Занятость

с. Частный бизнес

d. Денежные переводы

## **В. Ферма**

17. Каков размер ваших пахотных земель?

а. У меня нет пахотных земель

б. Менее 1 га

с. 1-3 га

d. 4-10 га

f. Более 10 га

18. У вас есть огород?

а. да

б. Нет

19. Вы что-нибудь выращиваете?

а. да

б. Нет

Если да:

19а. Что вы собрали на своих пахотных землях и / или в огороде за последние 12 месяцев?

---

20. У вас есть животные на ферме?

а. да

б. Нет

Если да:

20 а. Каких сельскохозяйственных животных вы разводили за последние 12 месяцев?

---

21. Какой процент продуктов питания поступает с вашей земли?

а. 0%

б. Менее 50%

с. Более 50%

22. Что вы делаете со своим урожаем / сельскохозяйственными животными?

а. В основном продаю

б. В основном самопотребление

23. Как далеко от вашего дома находится ближайший продуктовый магазин?

а. 2км или меньше

б. больше 2км

Г. Что вы употребляли за последние 24 часа?

| Время                                    | Составьте список того, что было потреблено | Ингредиенты блюд, которые вы употребили | Порция: тарелка / суповая чашка / чайная чашка / ложка / чайная ложка (используйте рисунки) | Комментарии |
|--|--|---|---|-------------|
| На завтрак?<br>Между завтраком и обедом? |  |   |   |             |
| На обед?<br>На полдник?                  |  |   |   |             |
| На ужин?<br>Вечером?<br>Ночью?           |  |   |   |             |

После, спросите, употреблял ли респондент какие-либо продукты из перечисленных ниже групп продуктов:

|   | Категории еды                               | Примеры местной кухни   | Да = 1<br>Нет = 0 |
|---|---|---|-------------------|
| A | Продукты из злаков                          | Рис, Каша, хлеб, лапша  |                   |
| B | Белые корнеплоды, клубни и подорожники      | Картофель или любые другие продукты, приготовленные из корнеплодов или клубней с белой мякотью, или бананов               |                   |
| C | Бобовые (фасоль, горох и чечевица)          | Зрелые бобы или горох (свежие или сушеные семена), чечевица или продукты из фасоли / гороха                               |                   |
| D | Орехи и семена                              | Любой древесный орех (например, грецкий орех), арахис / арахис или определенные семена или орехи                          |                   |
| E | Молоко и молоко Товары                      | Молоко, йогурт или другие молочные продукты, кроме масла, мороженое, сливки или сметана                                   |                   |
| F | Органное мясо                               | Печень, почки, сердце или другие мясные субстанции или продукты на основе крови, в том числе из дикой природы             |                   |
| G | Мясо и птица                                | Говядина, коза, дикое мясо, курица, утка или другая птица   |                   |
| H | Рыба и морепродукты                         | Свежая или сушеная рыба   |                   |
| I | Яйца  | Яйца из птицы   |                   |
| J | Темно-зеленый листовой овощи                | Перечислите примеры любых зеленых листовых овощей от среднего до темно-зеленого, включая дикие / собранные в пищу листья. |                   |
| K | Богатый витамином А овощи, коренья и клубни | Тыква, морковь, сладкий красный перец   |                   |
| L | Богатый витамином А фрукты                  | Абрикосы, арбуз, нектарин   |                   |
| M | Другие овощи                                | Перечислите примеры любые другие овощи  |                   |
| N | Другие фрукты                               | Перечислите примеры любые другие фрукты   |                   |

| O | Категории еды               | Описание / примеры  | Yes = 1<br>No = 0 |
|---|-----------------------------|---|-------------------|
| Q | масла и жиры                | Масло: жиры или масло, добавляемые в пищу или используемые для приготовления пищи, включая экстрагированные масла из орехов, фруктов и семян; и весь животный жир |                   |
| R | Несладкие и жареные закуски | Чипсы и чипсы, жареное тесто или другие жареные закуски   |                   |
| S | Сладости                    | Сладкие продукты, такие как шоколад, конфеты, печенье / сладкие бисквиты и торты, сладкая выпечка или мороженое.  |                   |
| T | Сахаросодержащие напитки    | Сладкие фруктовые соки и сокосодержащие напитки, безалкогольные / газированные напитки, шоколадные напитки, солодовые напитки,                                    |                   |

|   |                           |   |  |
|---|---------------------------|---|--|
|   |                           | йогуртовые напитки или сладкий чай или кофе с сахаром.  |  |
| U | Приправы                  | Ингредиенты, используемые в небольших количествах для ароматизации, такие как перец чили, специи, травы, рыбный порошок, томатная паста, ароматические кубики или семена. |  |
| V | Другие напитки и продукты | Чай или кофе без сахара и другие напитки: жарма, шоро, чалап, кымыз   |  |



Annex 6. Pictures from the field



Local food made of sheep intestines  
Photo credit: Aiperi Otunchieva



Local food: Lamb soup, meat and potato  
Photo credit: Cholpon Tashtanbekova



Women making type of bread (traditional food: fried dough). Photo credit: Aiperi Otunchieva



Tandyr for baking a bread  
Photo credit: Cholpon Tashtanbekova



Bread inside of the tandyr  
Photo credit: Aiperi Otunchieva



During the sewing process:  
making a local matras  
Photo credit: Cholpon  
Tashtanbekova

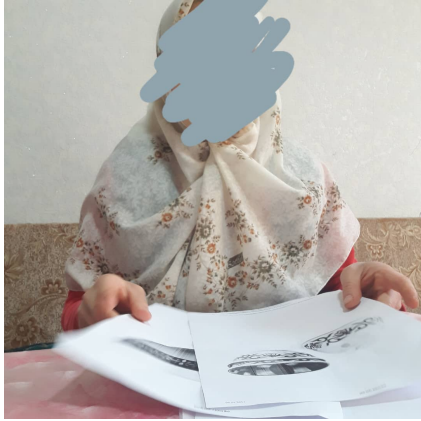


Yaks. Photo credit: Cholpon  
Tashtanbekova



Dung prepared for heating and cooking  
purposes. Photo credit: Aiperi Otunchieva

Demonstrating measure cups and utensils during the survey. Photo credit: Aiperi Otunchieva



Medical personnel teaching how to make height measurement  
Photo credit: Aida Baltabaeva



During milking a cow. Photo credit:  
Cholpon Tashtanbekova



During cooking process at home  
Photo credit: Cholpon Tashtanbekova



A woman with her kid drinking tea  
Photo credit: Cholpon Tashtanbekova



At the village store: all kinds of sweets are available. Photo credit: Cholpon Tashtanbekova



In city parks where families spend their leisure time. Photo credit: Aiperi Otunchieva



Carbonated and soda drinks, sweets, potato chips are sold



Barbery and herbs awaiting for clients in the road side



Local adaptation of pizza with salami and meat



Greeting guests with meat in a multi-generational household