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Navigating food environments for complementary feeding in the drylands of northern Kenya

Patricia J. Kiprono^{1,2} · Jennifer Kaiser¹ · Hussein T. Wario³ · Waliou Amoussa Hounkpatin⁴ · Brigitte A. Kaufmann^{1,5}

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Abstract

Despite numerous studies and aid programs, child malnutrition in African drylands remains a critical challenge for child growth and development. Although mothers are central to children's nutritional well-being, their perspectives are rarely prioritized. We seek to understand mothers' decision-making for feeding their children within the specific contexts of their personal food environments, including socioeconomic constraints and environmental conditions. Specifically, we analysed the influence of these constraints and conditions between locations and ethnic communities in Marsabit County, northern Kenya. We used a participatory approach for qualitative data collection to compare the extent to which women's personal food environments influence child-food provision among Rendille (pastoral), Borana (agro-pastoral), and Burji (crop-farming) communities. In 18 focus group discussions conducted in 2021–2022, women caregivers in six groups in these three communities rated and discussed up to 35 foods according to accessibility, affordability, convenience, healthiness, and acceptance by children. Mothers' perspectives on food characteristics associated with personal food environment factors vary depending on their contextual conditions. The ratings of food items according to these factors differed between the pastoral and agro-pastoral communities. The concepts of the food environment show how various factors affect mothers' food choices and child nutrition. These factors include location, livelihood systems, seasonality, infrastructure, household conditions, and food cultures. Therefore, food environment framing provides better strategies to inform interventions that aim to promote healthy and sustainable diets to improve children's nutrition and well-being.

Keywords Child feeding · Food security · Mothers · Food choices · (agro-)pastoralists · Tropentag 2023

1 Introduction

Malnutrition is a global health concern, particularly in dryland areas of sub-Saharan Africa where a high percentage of children are undernourished. Drylands are often economically marginalized, and large parts of the population

depend on primary production, either rain-fed cropping or rangeland-based livestock production. Marsabit County in northern Kenya lies in drylands, which constitute 80% of the country's total land area. Household food security directly impacts the availability and quality of food for children, often leading to child food poverty (UNICEF, 2024). However, food insecurity may vary among household members (Coleman-Jensen, 2020). For instance, disparities in food allocation within households can result in either children or adults being food insecure (Marinda, 2006). As defined by FAO, food security is achieved when individuals have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and preferences for an active and healthy life (FAO et al., 2020). It is a fundamental human right, aligned with the Sustainable Development Goals (SDGs), particularly Goal 2, which emphasizes zero hunger (United Nations, n.d.).

Sub-Saharan Africa remains the least food-secure region globally (FAO et al., 2024), with an average food security

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score of 47 based on the Global Food Security Index (GFSI), which is calculated using indicators of food security drivers, with 100 being the highest score. This makes sub-Saharan Africa the only region below the global average of 62 (Economist Impact group, 2022). Kenya's weak score of 53, though above the regional average, highlights persistent vulnerabilities. The country's weakest performance is in the affordability category (42), highlighting the high cost of food relative to household income and limited safety net coverage for vulnerable populations (Economist Impact Group, 2022). Such challenges have a direct impact on the food security pillars: availability, accessibility, utilization and stability (FAO et al., 2020) which in turn affect the complementary feeding of children.

In the context of food insecurity, it is important to understand how caregivers make decisions about complementary feeding and their practices. While quantitative studies on complementary feeding practices and their determinants are dominant in sub-Saharan Africa (Abebe et al., 2019; Amunga et al., 2022; Herman et al., 2023; Pacific et al., 2020), they primarily focus on measurable factors such as dietary diversity and nutritional status. However, these studies often fail to address the underlying reasons and broader contextual influences shaping these practices. In contrast, qualitative studies shed light on the environmental and socio-cultural factors influencing complementary feeding practices including but not limited to social support, autonomy, decision-making (Ickes et al., 2017), financial support (Ahishakiye et al., 2019), physical environment, and cultural food traditions (Duong et al., 2023). Despite their potential to provide deeper insights, qualitative studies remain limited in this topic and region.

Understanding complementary feeding practices is particularly relevant in the drylands, where malnutrition rates are high; and inadequate dietary intake is one of the immediate causes of malnutrition (Young, 2020). Poor dietary intake has been linked to women's inadequate knowledge and improper practices. Therefore, governmental and non-governmental organizations have implemented nutrition education programs to improve child nutrition. Studies have shown that nutrition education can improve knowledge and, in some cases, practices and nutritional status outcomes (Muluye et al., 2020; Saaka et al., 2021; Sharma et al., 2020). Success has been observed when considering different factors and sectors (Mulwa et al., 2023). To design more appropriate interventions, it is crucial to comprehend the decision-making process and constraints faced by women when feeding their children.

Food decision-making is a complex process influenced by sociocultural, economic, and environmental factors (Conteno, 2011; Enriquez & Archila-Godinez, 2022; Larson & Story, 2009). Mothers are considered primary caregivers of children and are often held responsible for childcare and

nutrition decisions (Muraya et al., 2017). Specifically, they decide what foods to give, when, where, and how to feed them (Mulville et al., 2022). These decisions are influenced by several factors including the physical and behavioural cues from the child (Blake et al., 2007; Hackett et al., 2015), societal norms of their ethnic communities, and respective food preferences (Reynolds et al., 2021), and household characteristics including their socio-economic status, size, composition and meal sharing customs (Ahishakiye et al., 2019; Monterrosa et al., 2012; Reynolds et al., 2021). Additionally, mother's knowledge, self-efficacy, and confidence in feeding their children (Herman et al., 2023) play a critical role in decision-making. Support from the family members and community can offer encouragement (Aber et al., 2018; Jongenelis & Budden, 2023; Ukoji & Fayehun, 2023), as well as informational support received from health workers, family, peers, and marketers about child foods and feeding (Boak et al., 2016; Pineros-Leano et al., 2019).

Moreover, women's perceptions and evaluations of food items strongly influence their decisions. These factors include costs, how easily they can obtain particular food from the market, and ease and time-saving in food preparation (Berhane et al., 2018; Boak et al., 2016). They also consider the consistency and taste of food (Hackett et al., 2015; Monterrosa et al., 2012) and its healthiness, which are related to its nutritional benefits, food safety, and quality (Berhane et al., 2018; Waters et al., 2018). Understanding mothers' food decision-making is a key factor in explaining practices for feeding children as well as the challenges faced hindering ideal nutritional outcomes and possible solutions to overcome these challenges.

To better understand food choices, the concept of food environment has recently been introduced (Blake et al., 2021; Turner et al., 2020). The food environment refers to the physical, economic, political, and socio-cultural contexts at the micro and macro levels, where the consumer interacts with the wider food system and makes decisions about what foods they will source, purchase, prepare, and consume (Downs et al., 2020; Turner et al., 2018). It is separated into external and personal food environments. Personal food environment factors influencing decisions about what foods to consume or to feed a child include accessibility, affordability, convenience, and desirability; the last refers to preferences, acceptability, tastes, and desires towards the food sources and products (Turner et al., 2018). Food security is influenced by both food environments and social capital (Choi et al., 2022; Paul et al., 2019).

Several studies have been conducted in the Global North to understand individuals' food environments, especially those related to obesity (Li et al., 2015; Penney et al., 2014). In sub-Saharan Africa, however, few studies related to food environments have been conducted (Auma et al., 2020; Dake et al., 2016; Fernandes et al., 2017) and very few related to

feeding and nutrition in young children (Pelto, 2015; Reynolds et al., 2021; Turner et al., 2020; Zobrist et al., 2018). Further research on food environments in Africa is needed to improve the health of the population (Laar et al., 2022). Using the concept of personal food environment, Berhane et al., (2018) demonstrated how factors such as convenience, children's preferences, food safety, and cultural aspects influence urban mothers' decision-making in Addis Ababa, Ethiopia. A study in Senegal showed mothers' evaluation of food items related to their personal food environment where soft and sweet foods were rated as highly accepted; vegetables, fruits, and eggs were rated as healthy; and most foods were not considered convenient, but the reasons for the ratings were not explained (Zobrist et al., 2018).

Food environments are context-specific and differ according to personal factors. Therefore, food environments can differ among people living in the same geographical location. Resource-poor settings, such as drylands in sub-Saharan Africa, face the challenge of a constrained food environment, thus limiting food choices. In Kenya, mothers' perceptions of the importance of personal food environment factors were compared between women living in Marsabit and other dryland and arid areas in the Kenya Focused Ethnographic Studies (Pelto et al., 2013; Thuita et al., 2019). However, these studies focused on a single pastoral ethnic community in North Horr sub-county, Marsabit County, among other communities and regions in Kenya. Our study builds on this foundation by examining variations in food environments among three ethnic communities (Rendille, Borana, and Burji) living in different locations in Marsabit County (Saku and Laisamis sub-counties- located in the highlands and lowlands respectively). This approach allows for a deeper understanding of how food environments vary within similar geographic contexts, considering the influence of location, ethnicity, and source of livelihood.

In this comparative study, we used a participatory methodology to understand mothers' decision-making regarding child foods and feeding within the specific contexts of their personal food environments, including socioeconomic constraints and environmental conditions. Specifically, we analysed the influence of these constraints and conditions between locations and ethnic communities in Marsabit County, northern Kenya. We compared women's perceptions and their personal food environments in Rendille (pastoral), Borana (agro-pastoral), and Burji (crop-farming) communities.

The specific objectives were to: (i) elicit mothers' perceptions of factors belonging to their personal food environments and identify differences in food environments even in the seemingly same dryland context; and (ii) understand mothers' characterization of common child-food items against their personal food environment factors. We thereby address the gap in existing literature where most studies

have used quantitative measures of food environment and complementary feeding factors, our study uses a qualitative approach to provide deeper insights into the contextual factors and their interconnections. It highlights the environmental and socio-cultural factors that shape maternal decision-making on complementary feeding (conceptual framework in Fig. 1).

2 Methods

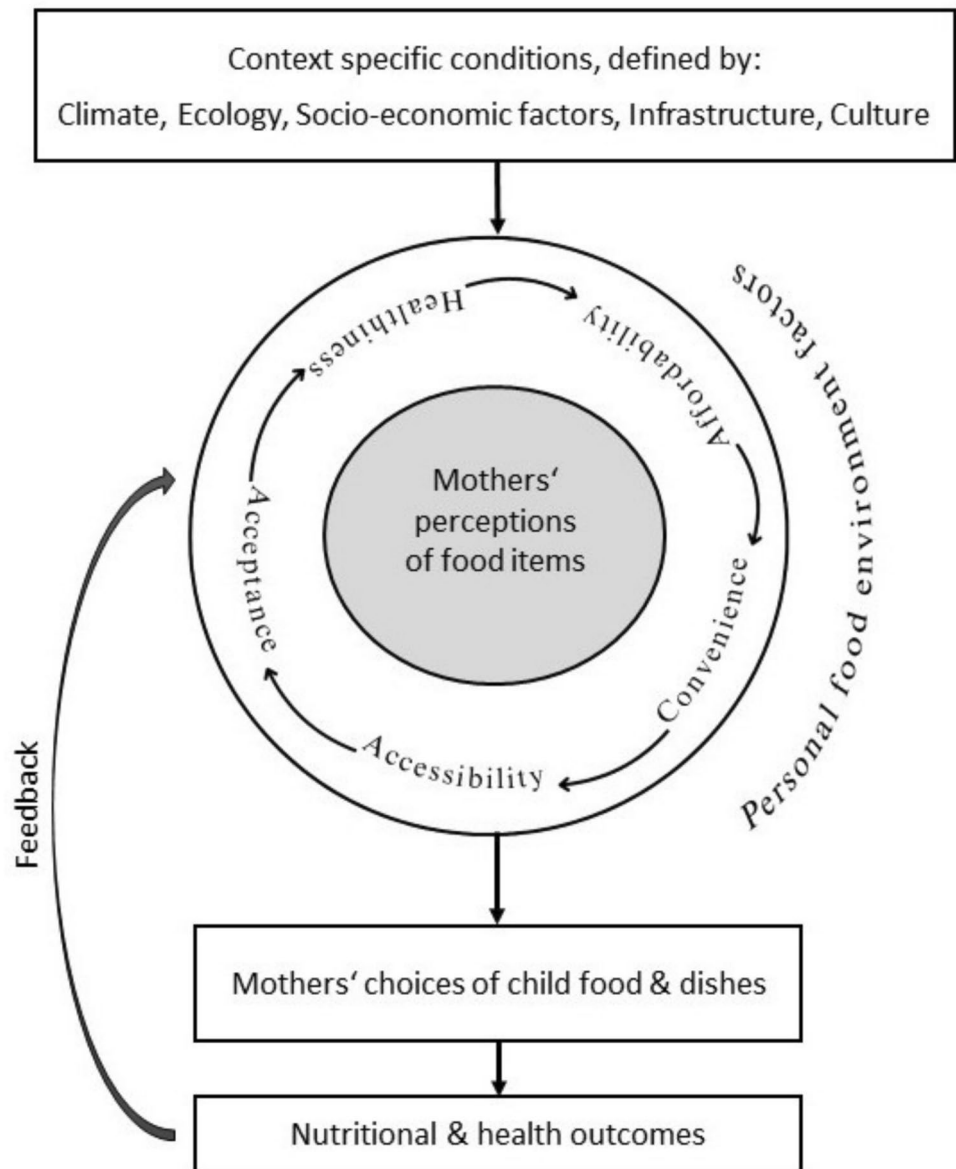
2.1 Study area

Marsabit County is an arid to semi-arid area with different agro-ecological zones. The average annual rainfall is between 200 and 1000 mm, making it one of the driest counties in Kenya. The region experiences two rainfall seasons, long rains between April and June, and short rains between October and December, with agricultural production primarily dependent on the long rains. It is inhabited by various ethnic communities such as Borana, Gabra, Rendille, and Burji. The different sources of livelihood in the county include pastoralism (81%), agro-pastoralism (16%), and others, such as formal employment, casual labour, and trading (3%) (Munene, 2019). The study was conducted in two sub-counties: Laisamis and Saku.

The Laisamis lowlands, 300 m above sea level, are arid with an average annual rainfall of 128 mm. The area around the small towns of Ngurunit and Korr (referred to in this paper as the Ngurunit-Korr study area) is inhabited by the Rendille community, pastoralists who raise their livestock in mobile systems. They keep their livestock close to their villages (*manyattas*) during the wet season when pasture and water are readily available; however, during dry seasons, they are taken to satellite camps and *fora* for better pasture and water. Men mostly move with the livestock during these times, leaving the rest of the household back in the village, but in some cases, the whole family relocates (FAO, 2020; Stites, 2021). Ngurunit-Korr in Laisamis is situated far from the main road and even further from Marsabit town, the County's capital.

Saku is located on the highlands at 1707 m above sea level, hence receiving higher rainfall with an annual average of 800 mm. It is inhabited by the Borana agro-pastoralists and Burji crop farmers, communities involved in this study (Pelto, 2015). Marsabit town, which is part of Saku, has a well-developed infrastructure, hence better access to water, markets, electricity, and other amenities, compared to the lowlands. Therefore, these two sub-counties are suitable for comparison due to their differing contexts despite their similar geographical locations. The contrasting conditions of these two locations are shown in Fig. 2.

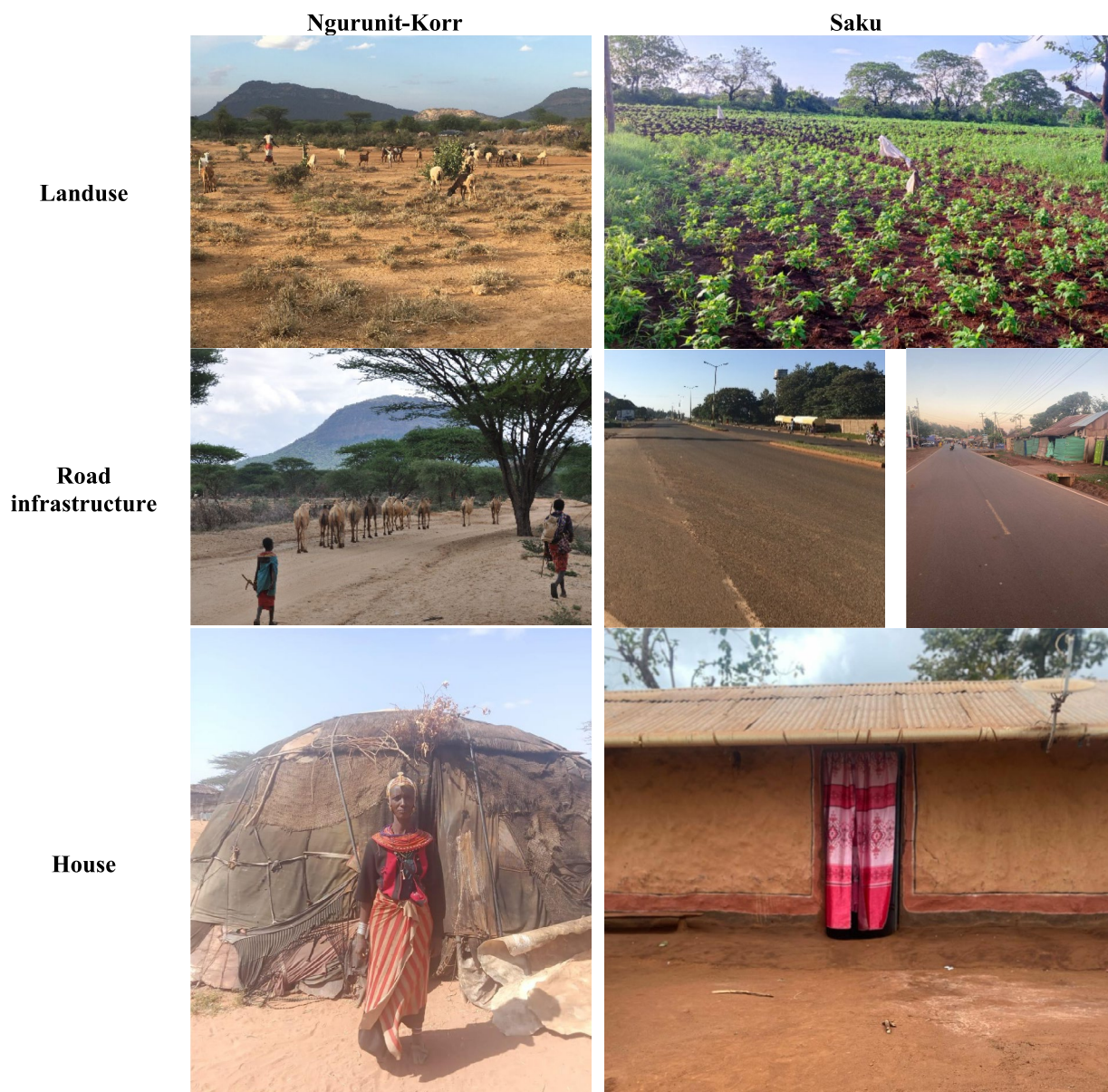
Fig. 1 Conceptual Framework for understanding mothers' decision making in food choices for child feeding within the food environment



Marsabit County along other Arid and Semi-Arid Lands (ASAL) in Kenya faced one of the worst droughts in the recent decades from 2021–2023 due to five consecutive failed rainy seasons. As of February 2022, 20% of the ASAL populations were experiencing acute food insecurity, classified as phase 3- crisis, according to the Integrated Food Security Phase (IPC) classification. Marsabit County was particularly affected with 50% of its population being acutely food insecure (phase 3) (IPC, 2022). The crisis was caused by multiple shocks in addition to the prolonged drought, such as local conflicts and effects of COVID-19 pandemic restrictions (Alulu et al., 2024; IPC, 2021, 2022).

These shocks impacted negatively on the availability, accessibility, and utilization of foods by the population. The consequences for food security were severe, as during the

prolonged drought, livestock, a primary livelihood source, suffered from poor body conditions, low selling prices, high mortality rates, and reduced milk production. This led to diminished household incomes, hence reduced purchasing power, while prices of staple foods and milk increased. These economic and environmental challenges affected the dietary intake of children and their nutritional status with high rates of malnutrition being recorded in the area (IPC, 2021, 2022). As of July 2022, 19.6% of children under the age of 5 years in Marsabit County were acutely malnourished, 30.5% were underweight, and 23.8% were stunted. In Saku, 10.6% were acutely malnourished, 19.6% were underweight, and 19% were stunted. The rates were higher in Laisamis where 30.3% were acutely malnourished, 47.1% underweight, and 31.2% stunted (Munene, 2023).



Pictures going across Patricia Kiprono (1,4a), Diba Tari (2), Lilli Scheiterle (3), Sulekha Abdulkadir (4b,6). Raphael Gudere (5)

Fig. 2 Contrasting conditions between the two study site locations of Ngurunit-Korr and Saku

2.2 Study design

This study was part of a larger collaborative project, ‘Enhancing women’s agency in navigating changing food environments to improve child nutrition in African drylands’ (NaviNut), which used a transdisciplinary approach to emphasize the integration of knowledge from different disciplines and societal stakeholders. The research team on the ground consisted of students and members from the local areas both men and women. They made exploratory field visits (January–April 2021) to introduce the overall

project idea to the different societal actors (mothers, other caregivers, and staff from local government and non-governmental organizations), to discover their particular interests, to form a consultative group with representatives from different societal actors, and to conduct various activities to build trustful relationships. Building trustful relationships is essential in participatory research as it creates a supportive environment in which mothers feel free to share their perspectives. Recognising and valuing them as key holders of local knowledge about child care and

nutrition fosters mutual respect and facilitates meaningful dialogue and information sharing.

To anchor the collaboration with mothers, the researchers surveyed existing women's groups as potential research partners from each of the two study locations, because we wanted to institutionalise the collaboration with the societal actors throughout the project duration. These women's groups, with 10–60 members each, have different purposes, such as promoting their food and culture, table banking (local saving and credit), or conducting financial investments together as self-help groups. Overall 9 women's groups were selected using purposive sampling to ensure representation from the different locations (Saku and Laisamis) and the three ethnic communities (Borana, Burji, and Rendille). The inclusion criteria were; women groups consisting of mothers and caregivers (e.g., grandmothers) of mixed ages both young and older women with children aged between 6 and 60 months living in their household, living in rural, peri-urban, or urban areas. In Laisamis, groups were classified as peri-urban when situated in close proximity to the markets and other amenities but overall the geographical location is considered rural. About 10–12 members from each group took part in the group discussions. These were members who were interested in NaviNut and lived close to each other. The inclusion of women's groups with different characteristics aimed to include a wide range of viewpoints and insights from different carers. This diversity was crucial in fostering collaborative learning both within and between groups, which is a fundamental aspect of transdisciplinary approaches and was emphasised in subsequent stages of the collaborative research (Kiprono et al., 2024).

Women's groups are very common in Marsabit county (Arasio et al., 2019), with both registered and informal groups existing. Membership provides several benefits, including access to pooled economic resources, opportunities to take loans, and mutual support due to strong social cohesion (Charity, 2014). This support often empowers women, enhancing their decision-making abilities and increasing their autonomy (Kenyatta, 2023). As a result, women who are organised in groups may have certain advantages over those who are not members. However, given that the majority of women in the region belong to such groups, the sample still reflects a representative of the wider population. Nevertheless, variations were observed within the groups, such as differences in wealth, education, and marital status, and these differences mirror those observed in the population as a whole.

2.3 Data collection and analysis

Data were collected using qualitative methods over 10 months between September 2021 and July 2022. There was close collaboration with the local research assistants

who understood the language and context. All participants provided informed consent prior to discussions. With the respondents' permission, discussions were audio-recorded. The step-wise procedure to data collection is summarised in Table 1. A total of 18 focus group discussions (FGDs) were conducted with the 6 women's groups (steps 1 to 3), plus 9 FGDs with 9 women's groups for the preliminary step. The researchers developed discussion guides for each step and used interactive techniques to understand mothers' criteria for choosing foods for their children.

Initially, free-listing exercises were conducted to identify the foods used in child feeding in the study area. Mothers in Saku listed 70 foods, while women in the Ngurunit-Korr area listed only 35; reflecting the limited access to diverse foods in the latter area. The researchers considered foods that were mentioned repeatedly across the groups to be common child foods: 35 of the 70 foods in Saku and 25 of the 35 foods among the Rendille in the Ngurunit-Korr area. The foods were either single foods, such as beans, or combined dishes, such as *fique*, which is a mixture of maize flour, wheat flour or barley, beans, moringa, and cooking oil or ghee. Pictorial food cards, showing a full picture of each food on a paper card, were printed and used in the subsequent rating exercises.

The first step was to ask mothers what factors they considered when making food choices for their children. Their answers were consistent with the personal food environment factors of accessibility, affordability, convenience, healthiness, and child acceptance, with the last two falling under desirability. The researchers shared this correspondence with the women so that they could understand that their perspectives were consistent with the literature and that the personal food environment factors could then be used in subsequent activities. The women then shared with the researchers the contextual meaning of these factors and their importance in children's food choices. This process revealed the local meanings of the personal food environment factors and how they might differ between mothers living in different locations in the drylands.

In the second step, the mothers characterised the common foods by rating them one by one using a participatory pile-sorting technique. The mothers rated each food item on a scale of 1–5 (5 being most favourable and 1 being least favourable) across all five personal food environment factors. The participatory process entailed group discussions to reach a consensus on each rating. Finally, the women gave detailed explanations of their ratings, providing insights into the reasons for their ratings and highlighting contextual factors that influenced their decisions.

Audio recordings from the interviews and discussions were translated and transcribed from the local languages into English. The first and second co-authors coded the qualitative data using MAXQDA, and the coding was reviewed by the other co-authors. The first two co-authors then conducted content analysis

Table 1 Step-wise data collection procedure

Preliminary step: Free listing exercise (9 groups, 9 FGD sessions)

The data collection began with a free-listing exercise during focus group discussion (FGD) sessions. Women from nine groups participated in this exercise to list various foods given to children in the region, categorized by the child's age or developmental milestones

- Saku groups identified up to 70 foods
- Laisamis (Ngurunit-Korr) groups identified up to 35 foods
- Common foods identified by both regions were selected for subsequent exercises: 35 foods from Saku and 25 foods from Ngurunit-Korr
- Food cards were printed for all common foods

Step 1: Understanding and defining factors shaping child food choices 6 groups; 6 FGD sessions

Step 1 a: Identifying factors influencing child food choices

- 6 FGDs were conducted in which women shared their perspectives on the factors they consider when choosing foods for their children. The initial question to the discussion was “*What factors do you consider/take in to account when making decisions on what foods you will feed your child?*”
- Mothers' criteria matched personal food environment factors (Turner et al., 2018) including accessibility, affordability, convenience, healthiness, and child acceptance, the last falling under desirability. This conformity with the personal food environment factors was shared with participants for validation and further discussion

Step 1b: Defining the personal food environment factors

- To understand the *contextual meaning of each factor*, women were asked to explain what accessibility, affordability, convenience, healthiness, and acceptance mean to them and their importance in child food choices. Explanations were sought for each factor separately

Step 2: Characterization of food items against personal food environment factors: (6 groups, 12 rating & discussion sessions)

Step 2a: Rating exercise

- Women engaged in a *participatory evaluation* process to assess food items based on the identified factors
- The rating process was structured using the Likert scale provided by the researchers 1–5 with 1 being least favorable and 5 being most favorable. The women conducted discussions amongst themselves and agreed on the final placements of the food items on the scales. The pile sorting technique was used in the rating exercise

Step 2b: Explaining the ratings

- Women gave detailed reasoning behind their ratings for each factor. Participants shared their thoughts on why specific foods were rated as 1, 2, 3, 4, or 5 in terms of accessibility, affordability, convenience, healthiness, and child acceptance. Their presentations were often followed by comments and discussions from other members which led to in-depth explanations

(Maxwell, 2012). First, they read all 19 transcripts to gain an overview of the information. They identified codes from the discussion guides and literature and noted those that are most useful for content analysis, such as market access, time required for food preparation, and food preferences. Each of the first two co-authors read the same four transcripts in detail using pre-identified codes as described above and new codes that emerged in the transcripts. They compared how they coded these transcripts and created a list of new codes. The other co-authors reviewed and fine-tuned the list and created a ‘final’ list of selected codes.

The ratings for each food item done by the six women groups were entered into an Excel spreadsheet and a descriptive analysis was carried out based on the calculated means and medians. There was little or no difference between the rural and peri-urban groups, hence the ratings were combined for each ethnic group. As the Borana and Burji communities had many similarities in their rankings, their results were grouped for the Saku location and compared with Ngurunit-Korr location, inhabited by the Rendille community.

3 Results

The results of this study provide insights into the decision-making processes of (agro)-pastoral women from the drylands of Marsabit County, northern Kenya. Drawing on

participatory focus group discussions and food rating exercises, the findings highlight the significance of the personal food environment factors (accessibility, affordability, convenience, healthiness, and child acceptance) by exploring what these factors mean to the women, and how they influence their food choices. The results also detail how women living in different locations characterise foods based on these factors. The findings reveal both similarities and differences in perceptions across ethnic groups and locations, reflecting variations in personal food environments influenced by factors such as climate (e.g. drought), environmental and socio-economic conditions, and cultural practices.

3.1 Characteristics of the sample

The participants comprised 61 women from six different women's groups, with ages ranging from 19 to 84 years. All participants were caregivers of children under the age of 5 years, the majority (77%) being mothers, while the rest were grandmothers. Most women had not received any formal education (67%), while a quarter (25%) had reached or completed upper primary education. The median number of children per household was 5, ranging from 1 to 10. The median age of the youngest child, all of whom were over 6 months and under 5 years, was 24 months. Additional

socio-demographic details are shown in * **MERGEFOR-MAT** Table 2.

3.2 Meaning of factors and differences in personal food environments of women living in lowlands and highlands

Following the food environment framework, this section examines how women in Marsabit County perceive and interpret the personal food environment factors in their context.

3.2.1 Availability and accessibility

Rendille women participating in the research described the availability and accessibility (*Heellin or Liwan in Rendille*) of food for children as strongly affected by seasonality, particularly concerning the availability of milk from livestock as a core complementary food for children. During the rainy season, lactating animals are kept near their homestead and milk is often available ad libitum. During the dry season, most animals are kept in satellite camps, which limits access

to milk in homesteads. A few lactating animals are usually kept near homesteads, but in times of extreme forage scarcity, no animals are left there.

“When it’s wet season when livestock is at home, when sheep and goats are at home because camels don’t stay at home we take a gourd, smoke it and milk some goats and give the milk to the children, during wet season we don’t have problem with planning and feeding of the children, you are not worried what to give to the child because milk is available.” (Rendille Mother, FGD).

The Rendille buy all other food in shops; the accessibility of which depends on the distance of the homestead from small centres or towns coupled with their financial situation. Suppliers bring food to the shops once a week or every two weeks, sometimes also close to the villages, or sell it from their vehicles on the roadsides. In the Rendille settlements, households have access to small mobile shops (women mainly sell cereals from their homes, which they source from the towns). Bigger shops with more foods such as fresh vegetables and fruits are only found in the town centres (Ngurunit and Korr). The accessibility of food

Table 2 Socio-demographic characteristics of the study populations

	Total (n = 61)	Ngurunit-Korr (Rendille) (n = 20)	Saku (Burji and Borana) (n = 41)
Child's characteristics			
Median age in months [min, max]	24.0 [8.00, 60.0]	24.0 [8.00, 60.0]	24.0 [8.00, 59.0]
Mother's/ Caregiver's characteristics			
Median age in years [min, max]	36.0 [19.0, 84.0]	39.0 [23.0, 84.0]	35 [19.0, 72.0]
Median number of children [min, max]	5.00 [1.00, 10.0]	6.00 [1.00, 10.0]	5.00 [2.00, 10.0]
Marital status, n (%):			
Single	0 (0%)	0 (0%)	0 (0%)
Married	53 (87%)	19 (95%)	34 (83%)
Separated	1 (2%)	0 (0%)	1 (2%)
Divorced	0 (0%)	0 (0%)	0 (0%)
Widowed	7 (11%)	1 (5%)	6 (15%)
Have co-wives, n (%)	11 (18%)	9 (45%)	2 (5%)
Formal education level, n (%):			
None	41 (67.0%)	19 (95%)	22 (54%)
Lower Primary	3 (5%)	0 (0%)	3 (7%)
Primary	15 (25%)	1 (5%)	14 (34%)
Secondary	1 (2%)	0 (0%)	14 (34%)
Tertiary	1 (2%)	0 (0%)	1 (2%)
Main income sources, n (%):			
Livestock	21 (34%)	20 (100%)	1 (2%)
Crop farming	6 (10%)	0 (0%)	6 (15%)
Formal employment	1 (2%)	0 (0%)	1 (2%)
Casual worker	20 (33%)	0 (0%)	20 (49%)
Self-employed	11 (18%)	0 (0%)	11 (27%)

from shops is limited due to the distance from settlements to markets (up to 20 km). The perishability of foods also limited access as it was not possible to buy in bulk and store. Therefore, Rendille women tend to buy foods with a long shelf life, such as cereals.

“...they are bringing [vegetables] after every two weeks; you know sometimes you wish to buy more so that you can give the child, but they get spoiled because our area is hot.” (Rendille Mother, FGD).

Borana and Burji women living in areas of higher elevation near Mt. Marsabit (agro-pastoralists and crop farmers in Saku sub-county) also linked food accessibility (*Argamisa in Borana*) to seasonality. For example, fruits and vegetables are abundant during the rainy season. Cereals are readily available until the harvested stocks are depleted and then have to be bought from the market. These women also consider food to be accessible if it can be easily obtained from their neighbours. Women living in peri-urban areas have access to shops in the main town to which they can walk or use motorbike taxis. Women in rural areas can buy most foods from small shops in their villages, and vendors are supplied from Marsabit town.

Foods that women rated high in terms of accessibility (ratings of 4 and 5) were those found in their homesteads, neighbours' homes, or nearby markets/mobile shops in the villages. Foods with low accessibility (ratings of 1 and 2) were only available during the rainy season or in markets far from the village.

3.3 Affordability

Affordability (*Tudubnan* in Rendille and *Dandeeti* in Borana) is closely linked to accessibility. An example given was that livestock products are less accessible to pastoralist households during the dry season and they must hence be purchased from the local market at high prices.

The women recognized that households differ in terms of their purchasing power because of differences in wealth;

‘...everyone you see around cooks according to what they afford to buy from the market. What you afford can be the things you have at your home but you don't have money; if one had money, they would have bought meat from the butchery...’ (Burji Mother, FGD).

To temporarily overcome the challenge of affordability, interviewed women reported frequently buying food on credit from local shopkeepers who knew them or from their women's groups if they were involved in the business of buying and selling food. Specific foods can also be purchased in small quantities; in some cases, affordable alternatives can be purchased, such as beans instead of meat.

‘It's bananas, oranges, mangoes, Irish potatoes, tomatoes and onions; these are available; they are also cheap and they are sold in small portions or quantities. You can buy a banana at ten shillings; if you have three children, you can buy three for thirty shillings; we can afford to buy if they are sold this way.’ (Rendille Mother, FGD).

The most affordable foods (ratings of 4 and 5) were those that were available in the women's homesteads or neighbours' homes, so no monetary exchange was required to obtain them. Foods rated high in terms of affordability were described as having a low market price when in season and were not as expensive when out of season. Foods prepared with a mix of ingredients that could be sourced from the farm and shops were rated as highly affordable. Mothers also bought food in bulk in the case that they were affordable and had a long shelf-life, such as rice. In some cases, rice and sorghum were received through food aid programs in 50 kg sacks, which could last for extended periods of time. The most expensive foods (ratings of 1 and 2) were not produced locally, or were seasonal foods that became very expensive during the dry season.

3.4 Convenience

Convenience (*Khokhani hii jiro in Rendille and Ir laaftu in Borana*) was described by the women in the study as reflecting the amount of time required for preparation to cook food – specifically, taking into consideration the amount of fuel and water needed. Cooking methods used to prepare food also determine the convenience of the food, for example, boiling and steaming. Foods that needed no preparation or took a very short time to cook could be used as snacks and fed to the child between the main meals. For example, fruit and milk are rated highly convenient. When a woman had little firewood for fuel, she prepared a meal that required a shorter time to cook. The women regarded foods that required a few ingredients, such as porridge and *ugali*, as convenient.

‘It [fife] contains beans that takes time to cook.’ (Borana Mother, FGD).

Other foods described as convenient were those that could be stored and consumed by older children in the absence of a caregiver, and foods that could keep a child satisfied longer. The least convenient foods (ratings of 1 and 2) were those that took a long time to cook and thus required more fuel and water. Foods that required other preparation steps, such as fermentation, which could take up to several days, for example, fermented milk or *qita*, were considered less convenient. Foods that were in a mixture of different ingredients, such

as *matoke*, took a longer time to cook and were therefore regarded as less convenient.

3.5 Acceptance by children

Acceptance was referred to as *Dhoona* or *Maahticha* by the Rendille women, and *Fud'atamisa* by the Borana and Burji. The women explained that they try to offer foods that their children like and that they adapt the food they offer to their children's individual preferences.

"The other factor is whether the child likes the food, not all the foods prepared are loved by kids. We as mothers, in most instances prepare foods that can easily be given and consumed very well by the child." (Borana Mother, FGD).

This involves interpreting signs that a child likes or dislikes a particular food, such as when a child eats well without being forced to. Highly accepted foods (ratings 4 and 5) are soft, sweet and tasty, either naturally (e.g. fruit) or with the addition of sugar or salt (e.g. porridge). Fatty or oily foods such as avocados are also highly accepted.

Food texture and taste play an important role: women reported that children do not like hard and dry foods, but prefer soft foods because they are tasty and easy for the child to eat. Foods that were poorly accepted by children (ratings of 1 and 2) were hard/dry, making it difficult for a child to chew, swallow and sometimes digest; those that were tasteless or had a bitter taste, such as moringa; and those that were fermented, such as *qita*.

Participants in the women's groups described how they offered foods that their children liked in terms of affordability and time. One woman illustrated her decision-making by saying;

'...and then during the wet season when time is favourable, the options change so that one can choose and say today I give fresh milk, tomorrow I give sour/fermented milk. That time we just monitor and feed children with the food they like' (Rendille Mother, FGD).

3.6 Healthiness

Healthiness was referred to as *Feiya* by the Rendille women, and *Irijirti/fayya* by the Borana and Burji. Participants in the women's groups described how they perceived the healthiness of foods and how they expected these foods to contribute to the growth and development of their children.

"The reason we give the food to our kids is because some protect the children from diseases, some improve their health and growth. Those are the benefits that

help us choose these foods according to our understanding." (Burji Mother, FGD).

The healthiest foods (ratings of 4 and 5) were those considered to promote children's growth, give them strength, be a source of vitamins, protect them from diseases, reduce susceptibility to disease, or manage symptoms in the case of illness, that is, medicinal. Women also regarded iron-rich foods, such as amaranths, as boosting and purifying blood. Nutrient-dense foods, such as *fique*, and enriched foods, such as porridge, were considered healthy foods.

'It [fique] has many ingredients such as moringa, beans, maize as a whole grain and fiber source' (Burji Mother, FGD),

Some women also noted the importance of dietary diversity for health, and the importance of food hygiene in promoting healthiness. Overall, women observed the health outcomes on their children.

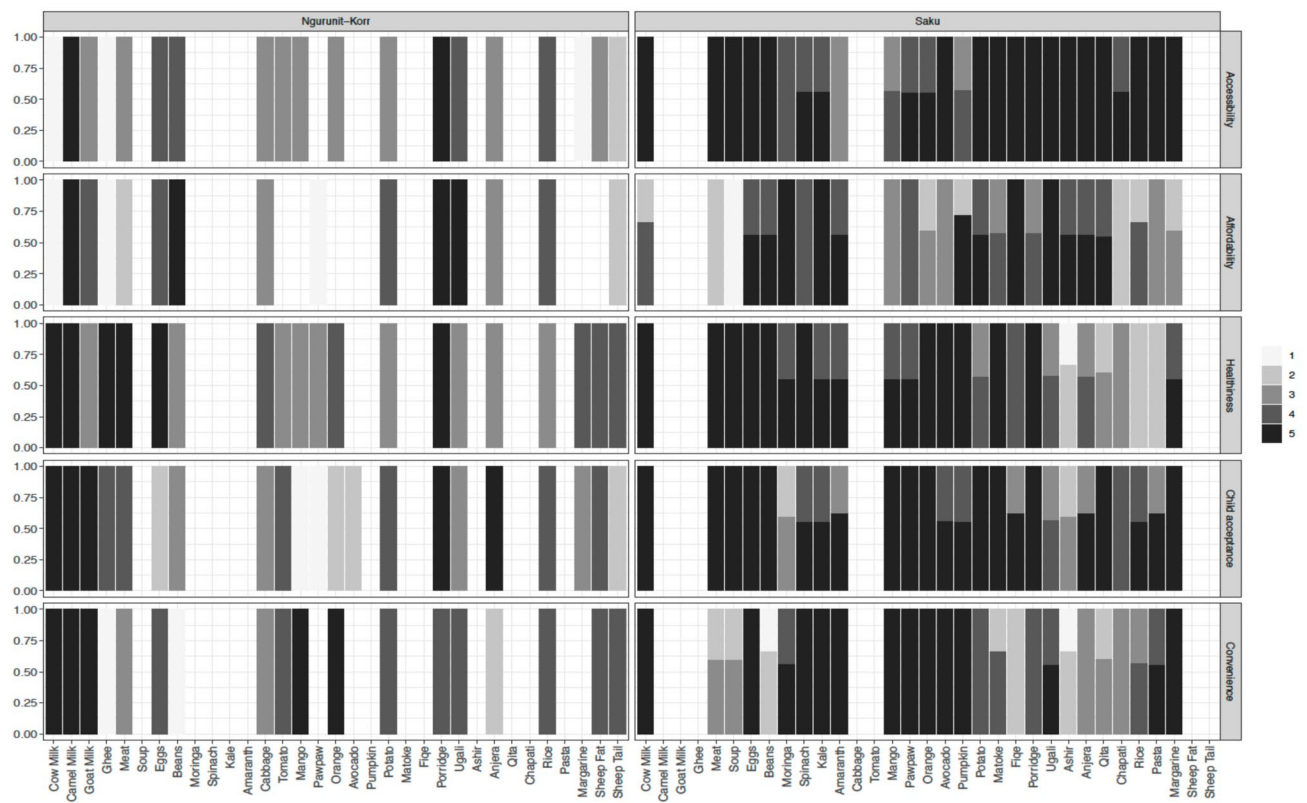
"When a child eats certain food, the body is utilizing the food well, the child is growing, he or she is not weak and again the child cannot fall sick easily." (Borana Mother, FGD).

The least healthy foods (rated 1 and 2) were those that filled the child's stomach but had little or no nutritional value. Dry and tough foods that could cause a child to choke, such as maize and *ashir*, were considered less healthy.

3.7 Women's ratings of children's foods

Women's evaluation of the different foods based on the personal food environment factors provides valuable insights into their food choices for child nutrition. The consensus-based ratings reflected their shared perceptions according to their experiences, conditions and contexts. Each food was evaluated based on several factors, but only a few food items consistently received high or low ratings. Trade-offs are therefore necessary when making food choices. The ratings of individual food items in Ngurunit-Korr (Rendille) and Saku (Borana and Burji) across the different factors; accessibility, affordability, convenience, healthiness, and child acceptance are illustrated in Fig. 3.

Some dishes can be considered cultural foods because they were originally used only by a particular ethnic community. However, especially in Saku, where Borana and Burji live close to each other, cross-cultural adoption takes place. They have also adopted some foods from other ethnic groups in Kenya. *MERGEFORMAT Table 3 gives the descriptions of these dishes and some foods that were referred to only in the local languages.



Scale of 1-5; 1 is the least favourable rating, e.g. least affordable, and 5 is the most favourable rating, e.g. most affordable. Foods have been organised according to food groups in this order; protein foods, vegetables, fruits, roots and tubers, cereals, and fats. Ngurunit-Korr represents the Rendille community and Saku, Borana and Burji; the latter having more similarities in their ratings. No shading indicates that the food was not rated in the locality, mostly because it is not available, thus not listed as a common child food, or was considered a seasoning or flavour, e.g. tomato in the case of Saku

Fig. 3 Ratings of child food items in Ngurunit-Korr (Rendille) and Saku (Borana and Burji) across the different personal food environment factors

3.7.1 Similarities and differences in ratings across locations

There was a high level of consistency in how women from the same ethnic group rated the foods for each factor. A few food items were rated consistently high or low across multiple factors by either all women's groups or specific ethnic groups. For instance, milk received high ratings across all factors for all women's groups. Eggs received a high rating across all factors by all groups, except the Rendille, who gave it a low rating with respect to its acceptance by children. A possible reason is that the Rendille have no tradition of eating eggs. Porridge was rated highly for availability, healthiness, and acceptance by children by all groups except the Borana, who rated it as moderately accessible. The different women's groups in the Saku area gave kale, avocado, and meat soup a generally high rating across at least three factors. Irish potatoes and moringa were rated highly across all factors by Borana women, and pumpkin by Burji. Maize

and *ashir* were among the foods that received low ratings for three or more factors.

3.7.2 Differences in ratings and their explanations

Differences in food ratings were pronounced between women living in the lowlands and those living in the highlands. While the accessibility of cow's milk, margarine, Irish potatoes and *anjera* was rated high in Saku, the first two were rated low in Ngurunit-Korr and the last two were rated moderate. Proximity to markets, frequency of food supply, and perishability of foods were the main factors influencing accessibility. For example, the supply of Irish potatoes in Ngurunit-Korr is limited and most women have to walk a long distance (e.g. between 5 and 20 km) to get them from the market. In addition, Irish potatoes are highly perishable in high temperatures, so they cannot be bought in bulk and stored, but must be consumed within

Table 3 Description of the local food items and quotes from women

Food item (language)	Description	Quotes about these foods from the women describing their characteristics and importance
<i>Anjera</i> (Boran)	Wheat flour or teff (<i>Eragrostis tef</i>) mixture with sometimes added eggs and sometimes also fermented	"...and in cases like when we are in a hurry we usually prefer foods that can be cooked faster for example I prepare <i>anjera</i> to avoid lateness." (Burji Mother, FGD) "the baby is given <i>anjera</i> and beans which help in blood boosting. They are mashed together because they all give energy. Sometimes, even egg is added to the <i>anjera</i> . If you soften it with beans children will eat a lot." (Rendille Mother, FGD)
<i>Ashir</i> (Boran)	Cooked dehulled maize (removing the husks is usually done at home)	"Ashir takes time to prepare because it has a lot of tasks, sometimes you might not have the mortar and pestle you borrow from neighbors but for maize flour, you can just buy ready and packed flour from the shop to prepare ugali." (Borana Mother, FGD)
<i>Chapati</i> (Swahili)	A type of flat bread made from wheat flour and the dough is prepared on a hot pan using cooking oil	"they normally consume it [<i>chapati</i>] especially from age two because it is tough." (Burji Mother, FGD)
<i>Fiqe</i> (Boran)	A mixture of maize flour or wheat flour or barley, beans, moringa, and cooking oil or ghee	"Fiqe, we prepare it using moringa, beans, and maize flour all those are readily available too." (Borana Mother, FGD) "Fiqe contains moringa and we normally make sure it is so soft for the child to consume and that it doesn't stick together like ugali." (Burji Mother, FGD)
<i>Githeri</i> (Kikuyu)	A mixture of maize and beans	"Githeri also takes longer to cook." (Burji Mother, FGD)
<i>Kukurfa</i> (Boran)	Wheat flour made into balls and put in boiling water to cook; served with other foods such as meat	"Kukurfa is good although it is big for the kids to get hold of them and eat, so we normally cut them into smaller pieces and feed them or give them to eat bit by bit." (Burji Mother, FGD)
<i>Mandazi</i> (Swahili)	Deep-fried dough made from wheat flour	"For example, in the case of mandazi, it is something that takes long to be prepared then cooked" (Borana Mother, FGD)
<i>Matoke</i> (Swahili)	A mixture of cooking bananas with other ingredients such as Irish potatoes, pumpkin, and kale or amaranthus leaves; some women add meat or beans	"Sometimes, you can rush to the shop and just buy mandazi..." (Burji Mother, FGD) "Matoke is also good, it builds the body so ... again we normally add other ingredients like potato and spinach which makes matoke very nutritious." (Burji Mother, FGD)
<i>Mokimo</i> (Kikuyu)	A mixture of Irish potatoes, green maize, beans, and green vegetables such as pumpkin leaves boiled and mashed, with oil or margarine added	"Matoke is also expensive, remember it's not green bananas only, it is a mixture of several food items including meat that's why we ranked it as expensive because some of the ingredients are very expensive." (Borana Mother, FGD) "... the foods in this category are mokimo because they contain a variety of foods that is potatoes, beans, oil, and others which makes the food expensive." (Burji Mother, FGD)
<i>Ngawa/Nkordo</i> (Rendille)	This is the Rendille name for fat from the sheep's tail. Is heated and used to enrich child foods such as milk and porridge. The tail can also be cooked and fed to a child, especially when starting to eat food	"... animal's fat is different [from the vegetable cooking fat or oil bought from the shops], if you add a small amount of animal's fat it's enough and it tastes good and the one from the shop is not like that. The child that uses animal fat is healthy and also other people who use it." (Rendille Mother, FGD)
<i>Omena</i> (Luo)	Also known as Lake Victoria sardine; small fish that are dried and cooked as a stew or ground into flour and mixed in porridge flour	"When children are almost one year of age, they do not like the smell of the omena [sardines] and therefore, we do not include it as part of the ingredients used in the preparation of the porridge." (Borana Mother, FGD)
<i>Qita</i> (Boran)	A mixture of maize and wheat flour usually fermented	"It has little benefit to the body and some like qita and ashir, kids can't eat because they are tough for their teeth" (Borana Mother, FGD)

a few days in the lowlands. In the Saku Highlands, their supply was regular, a shorter distance had to be travelled to reach markets, and because of the lower temperatures, Irish potatoes keep longer when stored.

Only the Borana rated cow's milk as affordable because they kept cattle and could get milk from their extended families and neighbours, whereas the Burji, as crop farmers, usually bought cow's milk. Cow's milk was also inaccessible to Rendille women, who mostly keep goats, sheep and camels. During the recent drought, milk sources became scarce and sharing between households was a common practice.

'...we have four lactating camels here we share milk among ourselves [households in the manyatta/village] using glass size cup. When we have these camels, we don't take black tea, we share.' (Rendille Mother, FGD).

In Saku, fruits are readily available during the season; for example, mango is available from January to April, and women consider it a source of vitamins. Women in Rendille rated most fruits not found wild in their area as expensive and not accepted by their children. For example, papaya (pawpaw) was considered expensive by the Rendille women. In contrast, the Saku women considered it affordable because they grow it at home, and it is affordable in the markets. Rendille children consume wild fruits when they are in season, but child acceptance is a challenge when it comes to some wild vegetables, for instance;

'lardo is available during the wet season, the whole family can eat, but children don't like it a lot because it's sour, but you can sweeten it' (Rendille Mother, FGD).

Women in Saku usually add margarine to children's foods to enrich them, whereas Rendille women use other products, such as sheep fat, for this purpose, which explains why Rendille gave margarine only a moderate rating.

However, even within the Saku location, differences between the Borana and Burji ratings. For example, unlike the Borana who buy pumpkins from the market, the Burji rated pumpkins to be affordable.

'We have it [pumpkins] in our farms and we don't need to spend money on it' (Burji Mother, FGD).

Burji rated *matoke* as low in convenience compared to Borana, who used fewer ingredients: Irish potatoes, green bananas, and green vegetables, while Burji also added beans and/or meat. Burji gave *qita* a moderate rating compared to Borana's low rating, as it's one of their cultural foods.

Moringa was rated as highly acceptable by the Borana women, but was rated low by the Burji women because of its bitter taste. However, the Borana had strategies to make it less bitter, such as using a wooden cooking stick rather than a steel spoon to stir it and mixing it with other tastier foods.

Qita which is considered a Burji food, was rated moderately by them, while Borana, who had adopted the food from Burji, gave it a low rating. *Anjera* was rated as healthy by the Borana women because they add eggs as a source of protein when preparing it, which was not always done by the women in the other groups, who gave it a moderate rating.

4 Discussion

This research used the food environment lens, specifically the personal domain, to understand the opportunities and challenges faced by mothers in their role of feeding children in agro-pastoral and pastoral areas of Marsabit County. This study revealed that the personal food environments of women living in adjacent areas of a county in the arid and semi-arid lands of Kenya can vary greatly. The personal domain of the food environment was explained by the women in their own understanding, which they used to describe their perceptions of specific foods according to each factor. Some of the explanations provided were similar to those given by women in other parts of Kenya (Kimiye et al., 2022; Peltó et al., 2013; Thuita et al., 2019) and globally (Duong et al., 2023; Zobrist et al., 2018) with some perceptions being unique to women in this study.

4.1 Accessibility

Accessibility was explained by physical access to food (homesteads, neighbours, distance to market, and mobile shops), seasonality, and storage possibilities. Own production made food more accessible, as seen among other women (de Bruyn et al., 2021; Duong et al., 2023), as did sharing food with neighbours which was common in these communities. Their explanations overlap with those in the literature (Auma et al., 2020; Duong et al., 2023; Osei-Kwasi et al., 2021) where accessibility is a key element that shapes one's activity space in terms of distance, place, space, and time (Herforth & Ahmed, 2015; Laar et al., 2022; Turner et al., 2020).

In both areas, accessibility was affected by seasonality: foods were more accessible and cheaper during the wet season. Food security and dietary diversity have been shown to differ across seasons (Auma et al., 2020; Gewa et al., 2019; Roba et al., 2019; Waswa et al., 2021) and more so for rural populations, with food insecurity and malnutrition being recorded during the lean seasons (Bonuedi et al., 2022; de Jager et al., 2023). Women who participated in the research in Saku Sub-county living near the county capital had better access to infrastructure for energy supply, transport, and markets, and thus better storage possibilities and access to perishable foods. They

could then purchase food in bulk, as was also observed among mothers living in the urban areas of Ethiopia with better infrastructure (Berhane et al., 2018).

Good access to markets, availability of food in markets, and diversified production increase households' choices, dietary diversity, and food security of households (Bellon et al., 2023; Chakrabarti et al., 2024). Drought has also been linked to the health and nutritional status of children in Marsabit County (Bauer & Mburu, 2017), a challenge commonly faced by populations in the ASAL areas. Similarly, among other agro-pastoralists in Kenya, milk becomes difficult to access during the dry season due to livestock migration (Kimiywe et al., 2022). This limited access to essential food items, such as milk, can threaten a child's nutritional well-being. A study conducted in Marsabit County further elucidates the relationship between distance to the market and the nutritional status of children aged 6–59 months. Their findings suggest that a greater distance is associated with an increased likelihood of stunting (Adongo et al., 2024a, 2024b). Furthermore, the dissemination of knowledge on the preservation of local foods could prove beneficial in improving accessibility during periods of drought (Catholic Relief Services (CRS) and USAID Nawiri, 2021).

4.2 Affordability

The affordability of foods was determined by the source of the food, seasonality, and wealth differences, which influenced the purchasing power of the mothers. Purchasing power influences whether one can access a food item from the market (Mphasha et al., 2022). One of the main predictors of the nutritional status of children aged 6–59 months in Marsabit County was the caregiver's income, where a higher income was associated with a reduced likelihood of the child being underweight (Adongo et al., 2024a, 2024b). Although pastoralists benefit from the self-production of animal-source foods, such as meat, these nutrient-rich foods are generally expensive in East Africa (Ryckman et al., 2021) particularly for rural populations with limited and variable incomes (Mwangome et al., 2010; Nordhagen et al., 2022).

Women who encountered difficulties in procuring food items due to their elevated prices devised strategies to obtain the desired foods, including buying smaller quantities, utilizing credit from shops, and selecting more economical alternatives. These findings are consistent with observations made among Gabra and Rendille women from North Horr and Laisamis sub-counties in Marsabit, as well as women from Isiolo County (Catholic Relief Services (CRS) and USAID Nawiri, 2021; Pelto, 2015). Women take credit from shopkeepers they know and have a preference for those who

provide credit (Chaudhuri et al., 2021; Monterrosa et al., 2012; Wanjohi et al., 2023). Other coping mechanisms such as reducing the frequency of consumption of certain foods (Chaudhuri et al., 2021; Monterrosa et al., 2012) and infants eating similar foods as the family (Matvienko-Sikar et al., 2018), have been adopted by women elsewhere to deal with problems of affordability. These mechanisms are strong indicators of food insecurity, reflecting how households are forced to cope due to challenges of limited accessibility and resources.

4.3 Convenience

This study shows a greater similarity between locations in terms of convenience ratings compared to other factors. However, there were some marked differences in living conditions (fuel availability, water availability and type) and food recipes. In Ngurunit-Korr, access to firewood was a challenge as women had to travel longer distances to get it, compared to Saku where women had access to firewood in town and in some cases were assisted by motorcycle riders or others to transport it to their homes. Rendille women chose foods that could be prepared more quickly or gave their children a snack before the main meal because of time constraints. Other studies have described convenient foods as ready-made foods that are considered unhealthy and highly processed (Erasmus et al., 2022; Matvienko-Sikar et al., 2018; Nordhagen et al., 2022). This was not the case in our study, where such highly processed foods are not common.

Differences in the food recipes used by the ethnic groups influenced convenience; for example, fermentation made *anjera* an inconvenient food. Women face time constraints due to their daily household chores, which may be worsened by the overall conditions of the household or its location, thus posing a challenge in providing desired foods for their children (Kimiywe et al., 2022; Matvienko-Sikar et al., 2018; Mazarello Paes et al., 2015). This is an opportunity for local processors to identify innovative foods that are convenient, healthy, and affordable so that mothers can access and use them to feed their children. This can also boost income generation for local processors.

4.4 Child acceptance

The acceptability of food by children is influenced by the cultural traditions of different ethnic communities. Women tend to cook foods that they themselves ate while growing up, so cultural knowledge and practices are passed down through generations (Berhane et al., 2018; Pineros-Leano et al., 2019; Spence et al., 2016). Only three foods were uniformly rated high, and one food was uniformly rated low in terms of acceptance by children across all groups, suggesting that culture was key in influencing children's acceptance of the

foods. Rendille women rated eggs low because they did not traditionally eat eggs and were now trying to include them in their children's diets. Eggs have also been shown not to be an easily accepted food in other parts of Marsabit County (Catholic Relief Services (CRS) and USAID Nawiri, 2021; FAO, 2020; Pelto, 2015) and in other parts of Kenya where it is seen as a source of income (Kimiye et al., 2022). However, our study showed a gradual increase in the use of eggs in children's diet. Foods that are culturally acceptable will influence mothers' choices and, therefore, children's acceptance (Erasmus et al., 2022). In addition to responding to their children's preferences, women also consider the needs of other household members when making choices (Flax et al., 2021; Monterrosa et al., 2012; Pineros-Leano et al., 2019; Wanjohi et al., 2023). This is particularly relevant when children start to eat family foods from the age of 2–3 years.

Women in the different locations in Marsabit County prepared similar foods for children such as porridge, but with variations in preparation, ingredients, and additives. These differences determine the texture and taste of the food. Women in the three communities modified the food to increase acceptance by using additives or serving it in combination with other foods to make it tastier and adding other foods to improve texture. Most indigenous vegetables, such as moringa and amaranths, have a bitter taste, and are not easily consumed by all populations, especially children (Gewa et al., 2019). Moringa was therefore added to other foods in a mixed dish, such as *fique* to mask its bitterness. The texture of the food changes as the child grows, starting with liquids, soft foods, less soft foods, and some chunks for integration into family foods. Therefore, a particular food texture can also determine the avoidance (Duong et al., 2023) or complete elimination of a certain food from a small child's diet (de Bruyn et al., 2021). *Fique* in particular was considered a dry and tough food, but ghee was added to make it soft and palatable for the child.

Food choice is also influenced by the social environment (Wanjohi et al., 2023) where women learn about different foods and how to prepare them from their peers through interaction and cultural exchange (Pineros-Leano et al., 2019). This was evident among the different ethnic groups in Marsabit County, where in the past, some foods that were consumed predominantly by a specific ethnic group are now being consumed by other groups. For example, moringa is known to be a Burji food, and Borana living in the same area have now learnt to consume this vegetable. Continuous learning and modification can be observed and built upon to improve children's feeding and nutrition.

4.5 Healthiness

Healthiness was defined in terms of the health outcomes of the child. The ingredients and recipes of a food item

were key factors in determining the healthiness of a dish. Strategies to enhance healthiness include enriching dishes with other food items such as milk or combining them with healthier foods. Agro-pastoral women in West Pokot (Kimiye et al., 2022) and Marsabit County (Pelto et al., 2013) have also been shown to enrich their foods such as porridge with milk but their modification strategies are limited (Kimiye et al., 2022). Women in both locations indicated that, a child needs to be given a variety of foods for a healthy diet and that monotony should be avoided. Thus, women are aware that the healthiness of single food items is not of paramount importance but rather that dietary diversity matters, which was also observed by other women in Kenya and Uganda (Mutuku et al., 2020; Nabuuma et al., 2021). Observing hygiene when handling foods promotes the prevention of illnesses and thus protects children's health and nutritional status (Kimiye et al., 2022; Nordhagen et al., 2022). Women in Marsabit and Isiolo counties also highlighted the importance of hygiene in child feeding practices. They expressed reluctance to feed fermented milk or preserved meat to younger children, fearing that these foods cause health problems such as diarrhoea. As a result, such foods were often reserved for adults and older children to minimise perceived health risks (Catholic Relief Services (CRS) and USAID Nawiri, 2021).

Women in all three communities observed the outcome of certain foods in their children in terms of growth, strength, and immunity to illness. This was also reported by a study targeting women in Isiolo and Marsabit counties (Catholic Relief Services (CRS) and USAID Nawiri, 2021). For example, moringa was associated with boosting immunity, and milk was associated with promoting growth. Women consider the health of their children when making decisions about which foods to offer (Farris et al., 2020; Flax et al., 2021; Pineros-Leano et al., 2019) and feel reassured when they have healthy children (Spence et al., 2016). This shows the women's inherent interest in providing their children with good nutrition. Women also observe their children's behavioural and physical changes in relation to food items over time (Erasmus et al., 2022). Mothers' observations of their children's health and dietary habits highlight the critical role of nutrient utilisation in promoting growth and nutritional status. This knowledge can be used in efforts to improve child nutrition through the use of locally available foods. While their knowledge of the effects of foods on children is based on their own experiences or that of their peers, their knowledge of the nutrients in foods is likely to have been gained through the health and nutrition education sessions provided by community health workers from the Kenyan Ministry of Health in local clinics and communities.

4.6 Linking accessibility to other personal food environment factors: affordability, convenience, healthiness and child acceptance

Accessibility influences other factors such as affordability, convenience, acceptance by children, and healthiness. Affordability was closely linked to accessibility, as foods that were accessible in the homesteads and from neighbours were most affordable. Women also considered the convenience of a food item depending on its source: if they had it in their household or could get it from their farm or a nearby market. Ease of access (proximity) affects the time a mother will take to access food and prepare it (Duong et al., 2023; Kimiywe et al., 2022).

The results of this study show that differences in food accessibility shape children's food preferences. Rendille children have a low acceptance to most fruits due to their limited exposure because fruits are usually not accessible due to the lack of nearby markets and their high perishability. Although cow's milk was not easily accessible to Burji and Rendille, the women rated it as highly accepted by their children. However, the most preferred milk among the Rendille was camel milk and cow milk among the Borana, reflecting the main livestock species kept by these respective groups and, thus, the type of milk that is more accessible. The influence of food accessibility on children's food acceptance was also demonstrated in a Senegalese study showing differences between children living in rural and peri-urban areas (Zobrist et al., 2018).

Similarly, accessibility influences the perceived health of food. For example, Rendille women rated all fruits as less healthy, whereas Borana and Burji women rated them as the healthiest. These fruits were not accessible in the arid lowlands, and some women were even unaware of some of the fruits. Among the four foods classified as healthy by all communities, the pastoralist community (Rendille) had access to only porridge. Hence, while Rendille women also desired to purchase foods known to be healthy, their poor access to these foods limited their ability to obtain them.

Women's characterization of food items compared to their personal food environment factors shows high consistency within one location and differs markedly between locations. In Saku, the women gave similar ratings to the foods in terms of affordability (79% of all foods), acceptance by children (82%), health and convenience (86%), and accessibility (89%). This reflects the similarities in the contextual conditions between the groups. Similar ratings revealed consistency in the perception and knowledge of women within a specific ethnic group in the same location. A recent study conducted by Adongo, Matofari, & Mbuthia (2024) in Marsabit, found differences in dietary diversity due to many factors including distance to the

market with the highest consumption of meat recorded in Bubisa, and the highest consumption of vegetables and fruits in Marsabit Central. This also shows the differences between locations in Marsabit County. The differences between Saku and Laisamis reveal how varied the food environments are despite being in the same county, which many mistakenly consider as the same kind of dryland area.

4.7 Strengths and limitations of the study

The transdisciplinary approach of the project allowed researchers and societal actors to collaborate at eye-level. The participatory and open interview methods used gave mothers the opportunity to freely share their perspectives and experiences with confidence and authenticity. The study was conducted among a marginalised population whose perceptions, interests and knowledge are usually given limited attention.

Within the overall four-year collaboration with the women's groups in the NaviNut project, the mothers gained more influence over the research activities, positioning them as co-researchers. The inclusion of women's groups from different locations and ethnic groups, and the diversity within the groups, in terms of age and caregiving experience, enhanced the findings by incorporating varied viewpoints.

It is important that we also share some of the limitations of the study and how we overcame some of the challenges. In transdisciplinary research, it is good practice to institutionalise collaboration with societal actors, which resulted in a relatively small number of sampled groups. The use of purposive sampling, a non-probability technique, limits generalisability. While this approach facilitated multiple interactions and in-depth discussions, a larger sample size and individual interviews would have provided opportunities to compare ratings taking into account individual and household characteristics. Although many women in the area belong to groups, working exclusively with group members may have introduced bias by not including women who do not belong to groups (possibly the most marginalised). However, the consistency observed in the results within a location, coupled with the marked differences between locations, suggests that the findings provide a valid representation of mothers' perspectives as influenced by their contextual conditions. As contextual conditions influence food environments and caregiver food choices, further research should be conducted to compare different ASAL regions in Kenya and sub-Saharan Africa, which may reveal additional variations in food environments and maternal decision making.

The study was conducted during a severe drought, the effects of which were even more severe in the lowlands of Laisamis. These extreme conditions may have influenced

participants' perspectives, despite efforts to focus discussions on their usual practices. It will be important to conduct further research that includes seasonal analysis, which would provide insights into how the situation changes over time, reflecting the variability of food security challenges.

Next to challenges typical for remote areas, there were severe instances of local conflicts and insecurity in the region during the study periods, which occasionally disrupted the research process. Working with women's schedules and availability proved essential to maintaining their motivation and ensure consistent attendance at sessions.

Despite these challenges, the data collected provided rich, context-specific insights into maternal decision-making and food choices in resource-constrained environments such as the drylands of northern Kenya. The findings therefore provide a basis for designing context-specific interventions to improve food security and child nutrition in similar settings.

5 Conclusion

Mothers' decision-making regarding complementary feeding is highly influenced by the respective local context comprising climatic, ecological, socio-economic, and cultural conditions that shape the respective food environments of (agro) pastoral households. Significant variations exist between ethnic groups and locations within Marsabit County, leading to notable differences in mothers' evaluation of food items and dishes across the factors- accessibility, affordability, convenience, healthiness, and child acceptance.

Women's characterization of food items also revealed their local knowledge and perceptions. For instance, when explaining which foods they consider healthy and linking them to observed health outcomes in their children. These evaluations were shaped by their daily experiences, reflecting living conditions such as access to water and firewood, the distances required to obtain these resources, seasonal variations, and recipes. Participatory approaches proved invaluable in uncovering these nuanced perceptions. These findings highlight the role of context, opportunities, and challenges in shaping maternal decision-making. It illustrates the intricate relationship between various factors including location, livelihoods, seasonality, infrastructure, household dynamics, recipes, and cultural influences.

Furthermore, this study demonstrates the diversity of personal food environments within the drylands of northern Kenya and the interdependence of the different factors within the personal domain. These factors interact dynamically within specific locations, highlighting the importance of adopting an integrative approach. Such an approach is crucial for understanding and addressing food security challenges and contributes to the development of actionable,

contextualised strategies to improve food and nutrition security, locally and globally.

5.1 Implications and recommendations

The in-depth insights on mothers' food choices in complementary feeding can provide support for the designing of tailored interventions aimed at improving child nutrition across diverse contexts and conditions. For example, in the lowlands in Marsabit county, improving market access through enhanced infrastructure and storage facilities would be critical to improving child nutrition as limited accessibility to perishable foods remains a significant challenge in the area. Designing interventions that respect and incorporate cultural practices is equally vital to ensure community acceptance and sustainability.

Establishing community platforms for knowledge exchange could further enhance efforts to improve personal food environments. These platforms would allow communities to share and adopt practical strategies, such as enhancing the healthiness and acceptance of foods by children through local modifications. Additionally, promoting the use of local and indigenous foods can also improve children's dietary intake. Such initiatives would leverage existing cultural knowledge while addressing gaps in nutrition.

At the policy level, this study contributes to global efforts to address food and nutrition security by emphasising the importance of integrating local knowledge into the design of interventions. This study is aligned with the global Sustainable Development Goals, particularly Goal 2 (Zero Hunger), and emphasises Kenya's constitutional commitment to ensuring access to adequate food as a basic human right. Furthermore, these findings underscore the broader applicability of context-specific and culturally sensitive approaches in enhancing the food and nutrition security of households and children in other resource-constrained and arid regions globally.

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Author contributions PK and BK designed the study. With guidance from HW, PK and JK collected data with the support of research assistants. PK wrote the manuscript. BK and HW reviewed and supported

the data analysis, provided feedback for improvements, and reviewed and edited the manuscript. WAH contributed to the interpretation of the work and review of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Data Availability The data that supports findings of this study are available upon reasonable request from the corresponding author.

Declarations

Conflict of interest The author(s) declare no conflict of interest with respect to the research, authorship and/or publication of this article.

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