Adolescent anaemia status and non-haem iron source food use at the Beddawi refugee camp in North Lebanon

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ABSTRACT

Palestinian refugees at long-term Lebanese camps are at increased anaemia risk. Adolescent Palestinians at these camps, with their disproportionately high poverty burdens, are at particular risk, though little-to-no data are available to describe this. Anaemia in Lebanon has been attributed, largely, to inadequate intake of bioavailable iron. This may occur when a population is reliant on non-haem iron food sources to meet nutrient needs, as is often the case in long-term camp settings. No studies are currently available that describe adolescent Palestinian diets at Lebanese camps. There is also a dearth of studies exploring food preparation practices that may be harnessed to optimise iron bioavailability from consumed foods at these camps.

This study used an embedded mixed-methods design to evaluate anaemia prevalence, iron source food consumption, and micronutrient dietary diversity (DDS-M) for a group of adolescent Palestinians (n = 66) at the Beddawi refugee camp in North Lebanon. The study also explored household plant-food use and preparation, with particular reference to dark leafy greens, and plant-food valuation with household food preparers (FPs).

Anaemia prevalence for adolescents was 29%. Median DDS-M was 4 [IQR = 1.63, range = 2-6]. Grain-based foods were consumed by the largest proportion of adolescents (100%), followed by milk source foods (84.8%) and fruits (59.1%). Jute mallow, chicory, parsley and spinach were the dark leafy greens used by the largest proportions of households (> 80%). Household use of a subset of dark leafy greens was positively associated with adolescent DDS-M (rho = 0.31, S = 14303, p-value = 0.03). All FPs reported plant food valuation; however, FPs in households with non-anaemic adolescents related plant food valuation responses with more detailed nutrient and health rationales than FPs in households with anaemic adolescents. Lemon juice, capsicum and chilli were among foods commonly reported to be co-consumed with plant meals described by FPs. Soaking pulses ahead of use was also reported.

Anaemia is a moderate public health concern for this group of adolescents, and the micronutrient content of their diets is insufficiently diverse. Increased consumption of accessible dark leafy greens and co-consumption of reported vitamin C-rich foods with non-haem iron meals, in combination with extending pulse-soaking practices to additional grains may contribute to optimising dietary and biochemical iron status for these adolescents.

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ABBREVIATIONS

AUB = American University of Beirut

BAZ = BMI-for-age *z*-score

BMI = body mass index

CDC = Centers for Disease Control and Prevention

DDS = diet diversity score

DDS-M = micronutrient diet diversity score

FAO = Food and Agriculture Organization of the United Nations

FFQ = food frequency questionnaire

FP = food preparer

FSANZ = Food Standards Australia New Zealand

HAZ = Height-for-age *z*-score

Hb = haemoglobin

IQR = interquartile range

M-DDW = minimum dietary diversity for women

mo = months

PI = primary investigator

PLO = Palestine Liberation Organization

sd = standard deviation

UN = United Nations

UNGA = United Nations General Assembly

UNHCR = United Nations High Commissioner for Refugees

UNRWA = United Nations Relief and Words Agency for Palestine Refugees in the Near East

y = years

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CHAPTER ONE: INTRODUCTION

Study background and research questions

Adolescence marks a developmental period of increased susceptibility to iron deficiency and anaemia given its characteristic increased growth demands, though it is also a period that is often overlooked in studies of iron health and nutrition intervention (Kurz, 1996). Meeting iron needs is more challenging in settings where vulnerabilities are compounded by high levels of poverty and associated food insecurity and aid dependency (Dye, 2007). As such, adolescents in these settings experience higher anaemia risk. This thesis explores adolescent anaemia in one such context: a long-term refugee camp in North Lebanon. Adolescent anaemia prevalence across long-term refugee camps is consistently high, and constitutes a moderate-to-severe public health concern in the majority of such settings across Asia and Africa (Engidaw et al., 2018; Khatib et al., 2010; Woodruff et al., 2006).

Lebanon is home to several long-term camps for Palestinian refugees. Palestinian displacement in the late 1940s led to a refugee situation that persists to today; it is one of the most protracted dependency situations to date. Lebanon is a country that has hosted Palestinian refugees since their initial displacement. Palestinian rights are severely constrained in Lebanon, which limits their social, economic and political participation in the host country (Suleiman, 2006). Palestinian refugees in Lebanon cannot obtain citizenship, and are applied an ambiguous legal status in the country (Al-Natour, 1997; Suleiman, 2006). They are barred from participation in a number of professions and are prohibited from owning land in the country (Suleiman, 2006). They are also routinely discriminated against in the employment they do find (Hanafi & Tiltnes, 2008). Surveys performed in Lebanon to assess the socioeconomic and health conditions of Palestinian refugees living there have demonstrated that the social exclusion and legal ambiguity applied to Palestinians in Lebanon have produced long-term poverty, which has also impacted education and employment trajectories, quality housing access, and health and food security outcomes negatively (Chaaban et al., 2010; Habib et al., 2014a; UNRWA & AUB, 2015). These surveys have also captured the disproportionate burden of poverty that adolescent Palestinian refugees at these long-term Lebanese camps experience (Chaaban et al., 2010).

Poverty is a major risk factor for anaemia development, and lower socioeconomic status has been demonstrated to be associated with anaemia risk for adolescents in a number of contexts (Bharati et al., 2009; Jalambo et al., 2013; Keskin et al., 2005; Kim et al., 2014; Soekarjo et al., 2001). The higher poverty rates observed at refugee camps likely contribute to the increased risk of anaemia in these contexts. In Lebanon, Palestinian adolescents have some of the highest

poverty rates in long-term camps (Chaaban et al., 2010; UNRWA & AUB, 2015). Despite this, and despite the protracted nature of the Palestinian refugee presence in camps in Lebanon, data on the nutritional status of adolescent Palestinian refugees is sparse. While limited data are available for the Lebanese refugee camp context, residence at these camps (i.e. when compared to residence in camps of other Arab host countries) has been identified as an anaemia risk factor for Palestinian refugee infants, attributable in large part to inadequate iron intake and/or low dietary iron bioavailability (Hassan et al., 1997; Yip, 1994). The latest anaemia prevalence data available for adolescent Palestinian refugees in Lebanese camps were published in 1962 (United States [US] Interdepartmental Committee on Nutrition for National Defense [ICNND], 1962). These data showed moderate-to-high levels of anaemia for the very small number of adolescent Palestinian refugees described in the survey. Given the dearth of available data on adolescent Palestinian anaemia prevalence despite the nutritional risk associated with the high poverty rates they experience in long-term Lebanese camps, this study aimed to collect data on anaemia status for a group of adolescents resident at the Beddawi refugee camp, a long-term northern Lebanese camp.

One major food-based risk for iron deficiency and associated anaemia is reliance on non-haem iron source foods as part of an unvaried diet (Zimmermann et al., 2005). Long-term refugee camps are contexts where diets are likely to be characterised in this way (Abudayya et al., 2009; Alemayehu et al., 2016; Banjong et al., 2003) and, as such, a focus on non-haem iron food sources is taken in this study. Increasing access to diverse diets high in bioavailable iron is one way of combating iron deficiency and mitigating anaemia risk in these settings. In long-term dependency situations characterised by restricted mobility, constrained legal and economic rights, and limited access to cultivable land, however, which is the case for Palestinian refugees in Lebanese camps, this option is likely not viable (Dye, 2007). Food fortification and iron supplementation are also potential options for combating iron deficiency; however, the protracted nature of long-term dependency situations undermines the sustainability of these strategies in these settings (Ruel, 2001). Food-based strategies that seek to harness the potential of accessible foods, then, may comprise more viable options for improving iron status where economic conditions are less changeable and where adequate long-term aid cannot be ensured. Where agricultural options (e.g. cultivating home gardens or raising livestock on a small scale) are limited, preferential consumption of readily accessible high-iron food sources in combination with maximising absorption of the iron present in available food sources may contribute to improving iron status sustainably in these communities (Batal & Hunter, 2007; Ruel, 2001).

As the focus of this thesis is iron adequacy in a situation of expected high plant-source food reliance, dark leafy greens with their diverse micronutrient contents and significant place in the traditional food systems of the participating refugee community and its host country (Batal & Hunter, 2007; Jeambey et al., 2009; Marouf et al., 2015) were plant source foods selected for particular exploration. Given the restrictions to land ownership for Palestinian refugees in Lebanon, and the limited space available to refugees in Lebanese camps to create home gardens, this study explored existing iron-linked food practices that have the potential to play a role in improving iron status for adolescents at the Beddawi camp. Two potential avenues through which this might be achieved were explored in this study: (i) increasing the micronutrient content of adolescent diets at the camp by identifying available food sources with high non-haem iron contents that might be promoted for preferential consumption, and (ii) determination of plant-food preparation and consumption practices that might comprise opportunities for influencing the bioavailability of non-haem iron present in regularly utilised foods at the camp.

The primary aims of this study, then, were to:

[1] Determine anaemia prevalence for a group of adolescent Palestinian refugees at a long-term Lebanese camp;

[2] Identify major iron contributors to adolescent diets at the camp; and

[3] Describe plant-food use, with reference to preparation and consumption practices that may be targeted to optimise the bioavailability of any non-haem iron present in the foods described.

The broad research question posed to achieve these aims was:

> *What dietary factors may be harnessed to optimise iron status and mitigate anaemia risk for adolescent Palestinian refugees at the Beddawi camp in North Lebanon?*

Seven questions subordinate to this overarching research question were also posed in order to address different aspects of it. They are:

> Research question 1: *What is the anaemia prevalence for a group of Palestinian adolescent refugees living long-term at the Beddawi camp?*
>
> Research question 2: *How diverse are the diets of these adolescents?*
>
> Research question 3: *To what degree are plant foods consumed by these adolescents compared with meat foods?*

Research question 4: *Do dark leafy greens – a food group that is part of the traditional food landscape of this community and also an important dietary source of non-haem iron – offer an avenue through which diets may be further diversified in the households of these adolescents?*

Research question 5: *Are plant foods valued differently by food preparers in households with anaemic compared with non-anaemic adolescents?*

Research question 6: *What plant foods are prepared in adolescent households at the camp?*

Research question 7: *How are plant-food contributors of non-haem iron usually prepared and consumed in these households?*

Study contribution

This study takes as its focus a largely overlooked group of nutritionally vulnerable refugees, with a view to highlighting the ongoing impacts of their marginalisation in their host country. This study proposes to offer new insights that begin both to characterise the anaemia status of adolescent Palestinian refugees living long-term at a large Lebanese camp, and to produce detailed food-based data that may be drawn upon to develop tailored, sustainable nutrition interventions for this group going forwards.

Chapter breakdown

This thesis is composed of nine chapters, the first being this introductory chapter. The next chapter in this thesis comprises the literature review, wherein literature used to develop the theoretical basis for pursuing this research is described along with a reiteration of the study's aims, a rationalisation of its research questions, and a statement of associated hypotheses. The third chapter in this thesis contains a description of the study's context. In this chapter, background on the Palestinian refugee presence in Lebanon and the conditions under which widespread poverty and associated nutritional vulnerability have arisen for this group is presented. Following this, in chapters four and five, the quantitative methods applied in this study and the results produced are detailed, respectively. These chapters contain the methods and results that are tied to research questions 1-4 and 6-7. Chapter four also details the mixed-

methods data collection approaches used. Chapters six and seven comprise each the qualitative methods and results sections of this thesis, wherein findings relevant to the remaining research question, i.e. 5, are detailed. An interpretation of the quantitative and qualitative findings of this study is then presented in the discussion chapter – the eighth chapter of this thesis. In this chapter, findings are contextualised within the existing relevant research literature, with specific reference to the aforementioned research questions. The discussion chapter also includes descriptions of the original contributions of this study. The final and ninth chapter of this thesis – the conclusion – outlines the study's limitations, proposes future study directions and also offers potential policy implications of this research. The chapter closes with a final summary of the research presented throughout.

CHAPTER TWO: LITERATURE REVIEW

This chapter comprises an exploration of literature key to framing the research reported on in this thesis. Adolescent iron requirement for girls and boys with reference to puberty status and age is outlined ahead of reports of anaemia prevalence for Palestinian refugees in Lebanon, as well as for adolescents in long-term refugee camps across Africa and Asia. Diet diversity and its relationship to dietary and biochemical micronutrient adequacy is discussed next, with particular focus on iron. Finally, haem and non-haem iron forms are explained ahead of a description of the impact of food components and preparation practices on non-haem iron bioavailability – the form of iron relied upon most in resource-poor, food insecure settings, including at long-term refugee camps.

Adolescent iron requirement and anaemia at long-term refugee camps

Iron requirement during adolescence

Iron requirement varies over the lifespan, increasing and decreasing in relation to changing developmental needs. Adolescence marks a period of rapid growth, and so is characterised by a relatively high iron requirement (Beard, 2000). Iron requirement increases during the pubertal growth spurt (Mesías et al., 2013). It peaks for male adolescents during this growth spurt, which occurs in late adolescence (i.e. 15-17 y) (World Health Organization, 2011). For adolescent girls, iron requirement is highest upon concurrent onset of menstruation during this rapid growth period, which occurs in early adolescence (i.e. 11-14 y) (Mesías et al., 2013; World Health Organization, 2011). Iron requirement is also impacted by the bioavailability of dietary iron, and a greater amount must be consumed where bioavailability of that iron is low (Hurrell & Egli, 2010). Changing iron requirements from late childhood through to late adolescence for girls and boys, and for varying degrees of dietary iron bioavailability, are summarised in **Table 1**.

Table 1: Iron requirement for older children and adolescents (10-19 y)

Developmental group	Iron requirement (mg/day)	Reference and value details
Girls and boys, 7-10 years	0.71	(Food and Agriculture Organization of the United Nations [FAO] & World Health Organization [WHO], 2001)
Girls, 11-14 years (not menstruating)	1.20	

Developmental group	Iron requirement (mg/day)			Reference and value details
Girls, 11-14 years (menstruating)	1.68			Median Total Absolute Requirement: To cover growth needs and basal and menstrual (where relevant) losses
Girls, 15-17 years (menstruating)	1.62			
Girls, 18+ years (menstruating)	1.46			
Boys, 11-14 years	1.17			
Boys, 15-17 years	1.50			
Boys, 18+ years	1.05			
	12%	10%	5%	(Food and Agriculture Organization of the United Nations [FAO] & World Health Organization [WHO], 2001) Recommended Nutrient Intake: To cover growth needs and basal and menstrual (where relevant) losses assuming 12, 10 and 5% dietary iron bioavailability, respectively
Girls and boys, 7-10 years	7.4	8.9	17.8	
Girls, 11-14 years (not menstruating)	11.7	14.0	28.0	
Girls, 11-14 years (menstruating)	27.7	32.7	65.4	
Girls, 15-17 years (menstruating)	25.8	31.0	62.0	

Developmental group		Iron requirement (mg/day)		Reference and value details
Girls, 18+ years (menstruating)	24.5	29.4	58.8	
Boys, 11-14 years	12.2	14.6	29.2	
Boys, 15-17 years	15.7	18.8	37.6	
Boys, 18+ years	11.4	13.7	27.4	

In resource-poor contexts, the nutritional vulnerabilities associated with these increased physiologic iron requirements during adolescence are exacerbated by reduced access to diets sufficient in bioavailable iron (Beard, 2000). One such high-risk setting is the long-term refugee camp.

Anaemia prevalence for adolescent refugees in long-term camp settings

Data describing adolescent anaemia status for Palestinian refugees in Lebanon are sparse, despite the moderate-to-high levels of anaemia reported for other adolescent refugee groups across a range of long-term camps in Africa and Asia (Engidaw et al., 2018; Khatib et al., 2010; Woodruff et al., 2006).

Anaemia estimates that may be derived for Palestinian adolescents at long-term Lebanese camps come from a survey conducted in 1961 (United States [US] Interdepartmental Committee on Nutrition for National Defense [ICNND], 1962). Participants included in this survey were Lebanese military personnel, Lebanese civilians, and Palestinian refugees at United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) camps. The UNRWA is the UN body responsible for providing health and education services for Palestinian refugees across five field sites (i.e. the West Bank, Gaza, Lebanon, Syria and Jordan) since their initial displacement. (Further socioeconomic and political context for the Palestinian refugee presence in Lebanon is explained in **Chapter three – Study context**.) In this survey, the camps in Lebanon from which participants were drawn were Nahr el-Bared, Ein el-Helweh and Baalbek. Haemoglobin (Hb) status was evaluated for refugee children, adolescents, and lactating and

pregnant women across these camps; however, the criteria against which biochemical outcomes were assessed in the report (i.e. age and cut-off levels) prevent anaemia prevalence from being described for all adolescent groups except the younger female and male adolescent groups. Drawing from these survey data, then, anaemia prevalence for female and male adolescent refugees aged 10-14 y was 50% and 25%, respectively, in this 1961 survey.

The most recent survey assessing anaemia status for Palestinian refugees in Lebanon is a 1990 survey of Palestinian infants across all five sites hosting Palestinian refugees long-term in camps established by the UNRWA (Hassan et al., 1997). As per data collected during these surveys, anaemia prevalence for all infants aged 6-35 mo was 70% (Hassan et al., 1997). These comprise the most recent data available for any Palestinian refugee group residing long-term at Lebanese camps (as of 2018).

These surveys, conducted decades apart, provide indications that the anaemia prevalence for young Palestinian refugees in Lebanese camps constitutes a moderate-to-severe public health concern. The high prevalence for infants in this 1990 survey may also indicate increased vulnerability for anaemia risk over the subsequent developmental periods of childhood and adolescence given this high risk for Palestinian refugees in early life. Further, although sample sizes from which anaemia prevalence estimates were produced in the 1961 survey were very small (n = 10 and n = 12 for females and males, respectively), the outcomes derived from the survey data are not unusual for adolescent refugees living long-term at camps in other countries.

For example, surveys undertaken in the late 90s in Kenya and Nepal in long-term camps in each region produced anaemia prevalence estimates of 46% and 24%, respectively. The surveys were conducted jointly by staff from the Centers for Disease Control and Prevention (CDC) and the UN High Commissioner for Refugees (UNHCR) at the Kakuma camp in Kenya and at seven Nepalese camps. Adolescents, who made up about a quarter of all refugees at each camp, were aged between 10 and 19 y, and both females and males were represented in these studies. Prevalence was also described in terms of sex and age. For both females and males at the Kenyan camp, anaemia prevalence was 46%, while at the Nepalese camps female anaemia prevalence was significantly higher than male (29% compared to 19%) (Woodruff et al., 2006). At both sites, anaemia prevalence was significantly higher for older adolescents (i.e. 15-19 y) than for younger (i.e. 10-14 y). Estimates reported for these two age groups at the Kenyan camp were 50% and 40% for older and younger adolescents, respectively (Woodruff et al., 2006). At the Nepalese camps, prevalence for the same age groups was 28% and 19%, respectively (Woodruff et al., 2006). Female anaemia prevalence was further described by puberty status in this survey. When

viewed in terms of puberty status, anaemia prevalence at both settings was higher for pubertal compared to pre-pubertal females (Woodruff et al., 2006). Prevalence for pubertal females at the Kenyan camp was 55%, compared to 36% for pre-pubertal females (Woodruff et al., 2006). Anaemia prevalence across Nepalese camps for the same groups was 37% and 17%, respectively (Woodruff et al., 2006).

Anaemia prevalence at the Kakuma camp in Kenya was higher than at the Nepalese camps, across the board. The final sample from the Kakuma camp had more males and older adolescent participants (i.e. aged 15-19 y) than females and younger adolescents, while participants were represented more evenly by sex and age in the Nepalese camps (Woodruff et al., 2006). The increased prevalence of anaemia found for older adolescents in both camps may be reflective of increased vulnerability to anaemia for older adolescents given increased physiologic need during this developmental period. In turn, this may have contributed to the higher prevalence reported in the Kakuma camp compared to the Nepalese camps. The findings from these studies demonstrate high vulnerability to anaemia for female and male adolescent refugees in two long-term camp settings. They also demonstrate higher vulnerability for older adolescents (i.e. 15-19 y) compared to younger (i.e. 10-14 y), and higher vulnerability for pubertal compared to pre-pubertal females.

Consistent with the findings at these camps, anaemia prevalence higher than 20% has also been reported for adolescents at Jordanian and Ethiopian long-term refugee camps (Engidaw et al., 2018; Khatib et al., 2010). Studies at both sites enrolled female participants only. Anaemia prevalence for females aged 10-17 y across the Ruwayshed and Al-Karamah camps in Jordan was 45% (Khatib et al., 2010). For female adolescents aged 10-19 y at the Aw-Barre refugee camp in Ethiopia, anaemia prevalence was 22% (Engidaw et al., 2018). Prevalence was not further described by age or puberty status in the Jordanian study; however, age was found to be associated with anaemia risk at the Ethiopian camp (Engidaw et al., 2018). The authors reported a doubled risk of anaemia for females in the older adolescent group (i.e. 15-19 y) compared to the younger group (i.e. 10-14 y) (Engidaw et al., 2018). While findings from these studies do not shed further light on anaemia risk by sex group, they further confirm prevalence outcomes consistent with moderate-to-severe levels of public health concern for additional adolescent refugee groups. The study conducted at the Ethiopian camp also further suggests that older adolescent refugees may be at higher risk of developing anaemia than younger adolescents in long-term camps.

In a study at the Khazana refugee camp in Pakistan, by contrast, no significant differences in anaemia prevalence were found based on sex or age group (Saeedullah et al., 2021). Anaemia prevalence for all adolescents aged 10-19 y in this study was found to be 10% (Saeedullah et al., 2021). This is the smallest prevalence estimate reported for adolescent refugees at long-term camps across Africa and Asia. Of those adolescents with anaemia at this camp, prevalence was 9% for females and 10% for males. In the older female and male groups, anaemia prevalence was 6% and 4%, respectively (Saeedullah et al., 2021). In the younger groups, prevalence was 3% and 6% for the same sex groups (Saeedullah et al., 2021). No significant prevalence differences were found between sex and age groups in this study.

Higher anaemia prevalence for male compared to female adolescents, and for pre-pubertal compared to pubertal adolescents, has also been reported in refugee camp contexts, demonstrating that its distribution by sex and pubertal status may be inconsistent across camp sites. At the Jabalia refugee camp in Gaza, for example, anaemia prevalence for all adolescents was 54%. Adolescent refugees included in the study were all aged 12-15 y, and so no comparisons were made for anaemia prevalence by age group in this sample. Male anaemia prevalence was found to be 60%, which was significantly higher than the prevalence of 48% found for females (Abudayya et al., 2007). This study also surveyed adolescents of the same age outside the Jabalia camp. While anaemia prevalence by puberty status was not reported for adolescent refugees alone, it was reported for all adolescents in the study. In contrast to the findings reported above for Kenyan and Nepalese camps, anaemia prevalence was significantly lower for pubertal compared to pre-pubertal adolescents in this Gazan study (Abudayya et al., 2007). Anaemia prevalence for pubertal females in the Gazan study was 35% and 47% for males (Abudayya et al., 2007). For pre-pubertal females and males, prevalence was 51% and 59%, respectively (Abudayya et al., 2007).

The findings reported on above demonstrate the relatively higher anaemia risk adolescent refugees experience at long-term camps. They further highlight that risk based on sex, age and pubertal status varies across camp settings. Adolescent anaemia prevalence reported for long-term refugee camps across Africa and Asia were found to range from 10 through to 54% (Abudayya et al., 2007; Engidaw et al., 2018; Khatib et al., 2010; Saeedullah et al., 2021; Woodruff et al., 2006). Prevalence estimates for adolescent groups across these camps fall predominantly above 20% and, as such, in the majority of cases, anaemia prevalence estimates for adolescent refugees resident at long-term camps are of moderate-to-severe public health concern. Further, distribution of anaemia prevalence by sex, age and pubertal status was not wholly consistent

across these camp settings, which suggests discrepant vulnerability in long-term refugee camp settings in terms of these variables.

Summary points

- The most recent anaemia prevalence data available for adolescent Palestinian refugees in Lebanese camps were produced in 1961 for a very small sample;
- The most recent anaemia data available for any Palestinian refugee group across Lebanese camps was produced in 1990. The survey reports on prevalence for infants, which was found to be 70%. In this survey also, Lebanese camp residence was found to be a risk factor for anaemia development in Palestinian refugee infants across UNRWA field sites;
- The majority of anaemia surveys conducted across adolescent populations in long-term refugee camps report prevalence > 20%, amounting to moderate-to-severe public health concerns;
- Anaemia prevalence and distribution for adolescents in these long-term camps varied by sex and pubertal status in these surveys. Although higher vulnerability was more often observed for female sex groups compared to male and pubertal compared to pre-pubertal groups, these findings were not consistent across all camps.

Associated study aim

Given the increased anaemia risk observed for adolescent refugee populations living long-term at camps across Africa and Asia, along with the dearth of data available for Palestinian adolescents in Lebanese camps, this study aimed to produce anaemia prevalence data for a group of adolescent Palestinian refugees at a long-term camp in Lebanon (i.e. the Beddawi camp in North Lebanon).

Associated research question

Research question 1: *What is the anaemia prevalence for a group of Palestinian adolescent refugees living long-term at the Beddawi camp?*

Associated research hypotheses

Anaemia prevalence for Palestinian adolescents at the Beddawi refugee camp was expected to be at least 20%. Anaemia prevalence was also expected to be higher for female compared to male adolescents and for pubertal compared to pre-pubertal adolescents at the camp.

Adolescent diet diversity: refugees

Diet diversity and iron status

Diet diversification is one food-based approach aimed at improving iron status in vulnerable populations. Dietary micronutrient status is positively impacted by increased diet diversity (Arimond et al., 2010). As an adequately diverse diet ensures consumption of a range of iron sources and nutrients that promote its absorption, this relationship may comprise an opportunity for improving iron status in vulnerable populations. Diet diversity, as represented by a diet diversity score derived from food record data, has been shown to have positive associations with dietary micronutrient adequacy for children, adolescents and adults (Arimond et al., 2010; Foote et al., 2004; Steyn et al., 2006; Torheim et al., 2004). Its relationship to biochemical iron status, however, is not as clear.

Diet diversity has consistently been shown to be associated positively with dietary micronutrient adequacy for a range of groups (Kennedy, 2009; Mirmiran et al., 2004; Torheim et al., 2004). The association has been demonstrated, for example, for diet diversity indicators representing a range of food-group aggregation states (i.e. 6-21) and across multiple study sites for non-pregnant, non-lactating women aged 15-49 y (Arimond et al., 2010). Increased diet diversity in this study was found to be positively associated with the probability of achieving micronutrient adequacy where eleven micronutrients, including iron, were examined (Arimond et al., 2010). Dietary data for these girls and women were obtained predominantly from single 24-hr recalls, and consumption from a food group was recorded at two levels: a 1g-minimum and a 15g-minimum (Arimond et al., 2010). The consistency of a significant positive relationship between diet diversity score and probability of achieving dietary micronutrient adequacy across all sites and for all levels of food-group aggregation speaks to the strength and reliability of this relationship.

The consistency of this relationship is also demonstrated in studies assessing the same in adult (>19 y) and elderly women and men (>60 y) (Foote et al., 2004; Rathnayake et al., 2012), in children aged 1-8 y (Steyn et al., 2006), and for male and female adolescents (10-18 y) (Mirmiran et al., 2004). Data from single 24-hr recalls were used to construct diet diversity variables in these studies. Diet diversity scores were produced in the majority of these studies, sometimes in addition to food variety scores, which used a count of individual food items consumed to reflect individual diet variety in the place of food groups. Whether food variety or diet diversity was used as the diet variety variable in these studies, associations between diet variety and dietary

micronutrient adequacy variables remained positive and significant (Foote et al., 2004; Rathnayake et al., 2012; Steyn et al., 2006).

Diet diversity has also been shown to be associated with dietary adequacy of individual nutrients that contribute to the construction of overall micronutrient adequacy scores, though findings for individual nutrients are not consistent across studies. Steyn *et al.* 2006, for example, found that each nutrient contributing to the overall micronutrient adequacy variable in their study was also associated positively with both diet diversity and food variety scores. The individual nutrients assessed in this study were: vitamin A, a range of B-vitamins, calcium, iron and zinc (Steyn et al., 2006). By contrast, Mirmiran *et al.* 2004 found significant associations for only some nutrients and not others. Dietary adequacy of vitamins A and B2, zinc, calcium, potassium, phosphorus and magnesium were found to be associated with diet diversity score, while the same was not found for vitamin C, iron and vitamin B1 (Mirmiran et al., 2004). Rathnayake *et al.* 2012 found positive associations between dietary diversity scores and calcium, iron and vitamins A, C and B1-3, but not for vitamins D, B9 and B12. These findings show that while dietary adequacy of individual nutrients is sometimes associated with diet diversity score, the relationship is not as consistent as the one observed for overall micronutrient adequacy.

Diet diversity has also been examined in relation to biochemical indicators of micronutrient status, and inconsistent outcomes have also been reported for these relationships. For example, Korkalo *et al.* (2017) examined associations between three diet diversity indicators and a suite of biochemical indicators of micronutrient status (including iron status) for adolescent girls aged 14-19 y in Mozambique, and found inconsistent associations between the dietary and biochemical variables. In the study, a diet diversity score was produced from 24-hr recall data for cases of a 0g-minimum and a 15g-minimum, respectively; these criteria were applied in order to consider a food group consumed. A diet diversity score was also determined through counts of food groups, with data obtained from 7-day food frequency questionnaires (FFQs). No minimum portion was ascribed for food group inclusion from FFQ data. Hb, serum ferritin, folate, plasma retinol and serum zinc were the biochemical variables assessed in the study. Dietary and biochemical data were collected during a major harvest season and in a season a few months before that. While the authors noted a positive association between diet diversity score and haemoglobin (Hb) and diet diversity score and serum ferritin in one model that used iron status cut-offs set from within the sample data, the most robust and consistent relationship was found between dietary and biochemical outcomes for serum zinc (Korkalo et al., 2017). Specifically, girls in the low diet diversity group (i.e. those in the 25th percentile for diet diversity scores within the study

population) were found to have higher odds of returning low serum zinc outcomes compared to those in the high diet diversity group (i.e. those in the top 25% of diet diversity scores within the study population) (Korkalo et al., 2017). This finding was only evident during the pre-harvest season, however, and not the harvest season (Korkalo et al., 2017). In summary, while a range of micronutrients were assessed in the study, only serum zinc was found to be associated with diet diversity, and only in one season of two. These findings suggests that, despite diet diversity generally correlating positively with dietary micronutrient adequacy and, sometimes, with dietary iron adequacy, this does not necessarily extend to biochemical micronutrient, or iron, adequacy.

Positive associations between these dietary and biochemical variables have been observed, however. Gonete *et al.* 2018 found that 'adequate' diet diversity, which they defined as consumption of at least 5 of 10 food groups, was associated with reduced anaemia risk, as represented by Hb concentration outcomes, for adolescent girls aged 15-19 y. Girls with 'inadequate' diet diversity (i.e. consumption from < 5 of 10 food groups) were found to have twice the anaemia risk of girls with adequate diet diversity (Gonete et al., 2018). Olumakaiye (2013) also found that for girls aged 10-19 y the risk of iron deficiency, as represented by serum ferritin combined with Hb concentration, was increased when diet diversity was low (i.e. ≤ 2 in the study sample) compared to high (i.e. ≥ 4 in the study sample). Increased anaemia risk has also been observed for pregnant women with low compared to high diet diversity scores (Saaka & Rauf, 2015), though the converse has also been observed (Saaka et al., 2017). For young children (aged 6 months to 5 y), too, anaemia risk has not been shown to be reliably higher for those with low compared to high diet diversity score (Saaka & Galaa, 2017), though it has been observed for some infant groups (Malako et al., 2018; Wang et al., 2015).

Diet diversity and iron status in refugee contexts

Few diet assessments have been conducted at long-term refugee camps. The assessments that have been conducted indicate that these are settings in which diets are insufficiently diverse, which is attributed, in large part, to the high rates of poverty in these camps (Ghattas et al., 2015; Morseth et al., 2017). In an assessment into diets of adult refugees (aged 18-82 y) in long-term refugee camps in Tindouf, Algeria, conducted by Morseth *et al.* (2017), for example, the average diet diversity score for this population was found to be 3.8 (sd = 1.4) food groups consumed of a possible 10 (Morseth et al., 2017). Two-thirds of participants were found to be at risk of inadequate diet diversity to support dietary micronutrient needs based on a 5-food group cut-off (Morseth et al., 2017).

The vulnerability of long-term refugees to dietary nutrient inadequacy has also been shown in assessments of diets at the household level (Banjong et al., 2003; Ghattas et al., 2015). At the Mae La refugee camp on the Thailand-Burma border, for example, Banjong *et al.* (2003) found that the majority of nutrients reported as consumed by households in the study came from supplied aid rations. Intakes of energy, protein, fats, iron, calcium, phosphorus and vitamins B1-3 came predominantly from ration foods, while intakes of vitamins A and C came predominantly from non-ration foods (Banjong et al., 2003). Of all nutrients assessed, only protein was consumed in amounts sufficient to meet 100% of daily needs (Banjong et al., 2003), demonstrating that dietary adequacy for long-term refugees may become seriously compromised in the absence of ration provision.

Decreased household consumption from a range of food groups has also been shown to be associated with food insecurity for Palestinian refugees living long-term at camps in Lebanon, as demonstrated by Ghattas *et al.* (2015), who found that a larger proportion of refugees at camps were food insecure compared to those living in gatherings in Lebanese towns and cities. Consumption of 6 (i.e. meat, dairy, fruit, vegetables, soda and sweets) of 7 food groups assessed was found to increase with increasing food security (on a scale of severely food insecure to food insecure to food secure), while increased consumption from the pulses food group, alone, was found to be associated with worsening food insecurity (Ghattas et al., 2015). This suggests that dietary nutrient adequacy is impacted by food security status. It also highlights that the high food insecurity associated with camp residence is reflected in increased nutritional vulnerability at the household level through decreasing access to a variety of food groups and, consequently, increased reliance on one.

The findings from these studies point to increased vulnerability to inadequate diet diversity for refugees at long-term camps at the individual and household levels. Given the relationship between diet diversity and dietary micronutrient adequacy, refugees at camps are, in turn, at increased risk of dietary micronutrient inadequacy.

Dark leafy green use and edible wild plants: Plant-based diet diversification

Dark leafy greens contain significant amounts of iron and a range of other micronutrients, and may comprise an acceptable, feasible option for diversifying diets for nutritionally vulnerable, food insecure groups (Powell et al., 2015). Consumption of dark leafy greens has been shown to be associated with increased diet diversity and, of the range of micronutrients present in these foods, iron has been shown to be present in appreciable quantities (Boedecker et al., 2014). The dark leafy greens food group includes the subgroup – edible wild plants. Edible wild plants refer to

plant foods that have been sourced from wild plots of land, as opposed to plants harvested from domesticated crops (Turner et al., 2011). While historically these plants may have been harvested from strictly untended plots, today many of them undergo a degree of tending (Turner et al., 2011). They may also be grown in amongst domesticated crops (Turner et al., 2011). This subgroup also has the capacity to contribute significantly to diversifying diets, and so meeting dietary micronutrient needs, in populations that make use of them. This has been explored by Boedecker *et al.* (2014), for example, who found that edible wild plant use was positively related to both diet diversity and dietary micronutrient adequacy for non-pregnant, non-lactating women (aged ≥ 18 y) in a rural area of Benin. Specifically, women who reported consumption of edible wild plants were found to have significantly higher diet diversity scores and overall dietary micronutrient adequacy compared to women who reported no consumption (Boedecker et al., 2014). While the micronutrient contribution of these plants to diets was not found to be large, and while the majority of micronutrients examined were not found to be consumed in adequate enough amounts to meet daily needs for these women, the significant contribution that edible wild plant consumption did make to improving diet quality for consumers speaks to their potential for attenuating nutritional vulnerability in resource-poor communities, if their consumption can be increased (Boedecker et al., 2014).

Dark leafy greens and edible wild plants comprise accessible plant-source food groups that have the potential to offer diet diversification routes for Palestinian communities in long-term Lebanese camps. Edible wild plants comprise an important food group in the traditional food systems of Palestinians (Ali-Shtayeh et al., 2008). The leaves and stems of edible wild plants are used most commonly from these plants, and they are used as foods and medicines (Ali-Shtayeh et al., 2008). Such plants are also an important part of the traditional food landscape of Lebanon, where they are used for similar purposes (Marouf et al., 2015). In Lebanon, they are collected from wild plots by members of a household, or they are bought from local markets or independent collectors (Marouf et al., 2015). As with edible wild plants in other regions, those in Gaza, the West Bank and Lebanon comprise a combination of plants that are wild, as well as counterparts that are cultivated to some degree (Ali-Shtayeh et al., 2008; Marouf et al., 2015). The substantial micronutrient contents of a number of these plants, including their contents of iron, have been evaluated with reference to traditional meals that put these plants at their centre (Batal & Hunter, 2007; Cowan et al., 1963; Cowan et al., 1967). These foods have been demonstrated to be utilised regularly in these communities, both urban and rural, and to hold cultural, religious, medicinal and nutritive significance for collectors and preparers of these plants (Batal & Hunter, 2007; Jeambey et al., 2009; Marouf et al., 2015). The value of these foods is demonstrated in

their continued use; however, reports also suggest that collection and use of these plants has diminished over time and concurrent to health and nutrition transitions occurring in these communities that tend away from traditional food systems and move toward reliance on refined grains and fast foods (Batal & Hunter, 2007).

Summary points

- Diet diversity is consistently positively associated with dietary micronutrient adequacy across age and sex groups, including for female and male adolescents;
- Diet diversity has also been shown to be associated positively with dietary adequacy of individual nutrients, including iron;
- Despite the consistent relationship between diet diversity and dietary micronutrient adequacy, the relationship does not extend reliably to biochemical micronutrient status. Iron is one micronutrient for which this relationship was sometimes observed and sometimes not;
- In refugee camp contexts, for which diet assessments are largely unavailable, diet diversity has been shown consistently to be compromised for individuals and households;
- Lebanese camps are contexts of increased food insecurity risk for Palestinian refugees resident therein;
- Lebanese and Palestinian food systems include a culturally and nutritively significant dark leafy green-edible wild plant component that comprises a potential plant-based avenue for diversifying diets.

Associated study aims

The dearth of data available on long-term refugee diets despite increased risk of poverty, food insecurity and dietary nutrient inadequacy speaks to the need for characterising diet diversity outcomes in such situations. Given this, as well as the high food insecurity experienced by Palestinian refugees resident at Lebanese camps and its relationship to reduced consumption of a range of food groups that contribute to diversifying diets, this study aimed to characterise diets of adolescent participants at the Beddawi camp with reference to diet diversity. The study additionally aimed to examine the proportions of adolescents reporting consumption of a range of food groups, including those of particular relevance to iron status. Further, this study aimed to evaluate household use of dark leafy green and edible wild plants, with a view to exploring whether increasing consumption of these plant foods could be viably recommended as a diet diversification strategy in this population. Diet diversity, iron source food consumption and dark leafy green-edible wild plant use were also compared for anaemic compared to non-anaemic

adolescents. Finally, this study aimed to examine food preparer valuation of plant foods. Comparisons were made for these data to explore whether plant foods were valued differently in households with anaemic compared to non-anaemic adolescents.

Associated research questions

Research question 2: *How diverse are the diets of these adolescents?*

Research question 3: *To what degree are plant foods consumed by these adolescents compared with meat foods?*

Research question 4: *Do dark leafy greens – a food group that is part of the traditional food landscape of this community and also an important dietary source of non-haem iron – offer an avenue through which diets may be further diversified in the households of these adolescents?*

Research question 5: *Are plant foods valued differently by food preparers in households with anaemic compared with non-anaemic adolescents?*

Associated research hypotheses

Adolescent diets at the camp were expected to be insufficiently diverse. Insufficient diet diversity would be represented by an average diet diversity score reflecting consumption of fewer than half of all food groups included in the score's calculation. High levels of pulse and grain consumption were also expected, along with comparatively low levels of meat consumption. Increased dark leafy green and edible wild plant use was also expected to be positively associated with diet diversity.

Household plant-food use and iron status

The inconsistent relationship between diet diversity and biochemical iron status despite associations between the former and dietary micronutrient and iron adequacy may speak to a reliance on non-haem food sources of iron and the complexity of non-haem iron bioavailability. Additionally, while diet diversification offers one avenue through which biochemical micronutrient status may be optimised, this option may not be viable on its own in situations of high poverty where food variety cannot be increased easily. The bioavailability of the non-haem iron in available food sources in such settings, then, is of prime importance, in addition to diversifying diets through accessible foods, for acting on iron status through diet.

Non-haem iron bioavailability

Consumed iron is categorised as either haem or non-haem in form (Fuqua et al., 2012). Haem iron is provided by flesh foods only, while non-haem iron is present in both flesh foods and plant foods (Hurrell & Egli, 2010). Haem iron is absorbed more readily than non-haem iron in the small intestine (Fuqua et al., 2012). Non-haem iron undergoes an additional reduction ahead of entry into cells of the small intestine, and this reduction step is one point at which the bioavailability of non-haem iron may become compromised, as other food components may either aid in its reduction and promote its absorption or form insoluble complexes with it and so impede its entry into intestinal cells (Fuqua et al., 2012; López & Martos, 2004). Co-consumption of vitamin C and meat, for example, can enhance the solubility of non-haem iron, while food components such as phytates and polyphenols can decrease its solubility (Hurrell & Egli, 2010; López & Martos, 2004).

The respective effects of enhancers and inhibitors on non-haem iron absorption have been demonstrated to be dose-dependent, and minimum amounts associated with significant enhancing or inhibiting effects have been identified for each (Baech et al., 2003; Hallberg & Hulthén, 2000; Siegenberg et al., 1991; Zijp et al., 2000). Vitamin C in amounts of at least 30mg has been shown to overcome phytate inhibition of non-haem iron absorption, which has been observed to take place when amounts as small as 2mg are present in a meal (Siegenberg et al., 1991; Teucher et al., 2004). Meat co-consumed with non-haem iron meals has been shown to improve its absorption significantly when at least 50g is consumed with a meal high in phytates (Baech et al., 2003). Vitamin C and meat have each also been shown to increase non-haem iron absorption in the presence of polyphenol inhibitors (e.g. tannic acid) (Hallberg & Hulthén, 2000; Morck et al., 1983; Siegenberg et al., 1991; Tuntawiroon et al., 1991).

These inhibitors are present in significant amounts in plant source foods and, as such, attenuating their relative impacts on non-haem iron bioavailability is imperative in the context of diets heavily reliant on such food sources for meeting daily nutrient needs (Sandberg, 2002). Altering levels of these enhancing and inhibiting food components, either through their increased or decreased co-consumption with a non-haem iron meal or through food processing techniques that preserve or degrade them, can make significant differences to non-haem iron bioavailability (Gibson et al., 2006). Soaking grains, pulses and legumes ahead of their use in meals is one strategy that may be employed, for example, to reduce the phytate content of these plant source foods and, consequently to increase the bioavailability of any non-haem iron present in the meal (Gibson et al., 2006). Heat processing subsequent to soaking can further reduce the phytate content of

these foods (Gibson et al., 2006). Fermentation and germination have also been demonstrated to reduce phytate content of plant source foods and to contribute to increases in the micronutrient content of a plant source food (Gibson & Hotz, 2001). Combining phytate reduction strategies with the co-consumption of vitamin C and/or meat in a non-haem iron meal can further enhance its bioavailability (Gibson & Hotz, 2001).

Non-haem iron consumption and biochemical iron status: Resource-poor contexts

The widespread poverty and high food insecurity characteristic of long-term refugee camps reduce accessibility to a range of food items and increase reliability on others. As described earlier, Ghattas *et al.* (2015) have demonstrated that household consumption of meat, dairy, fruits and vegetables is reduced for long-term Palestinian refugees in Lebanon for progressively worsening food insecurity outcomes, while consumption of pulses, a plant-based iron source food group, increases. Banjong *et al.* (2003) similarly reported increased plant food reliance at the Mae La refugee camp on the Thailand-Burma border for a situation of increased poverty and food insecurity, evidenced by heavy reliance on external aid to meet daily nutrient needs. The study reported that with respect to protein consumption, i.e. the only nutrient consumed in amounts sufficient to meet daily needs, plant, and not meat foods, were the predominant source of consumed protein (Banjong et al., 2003). Additionally, the major source of iron for refugees at this camp was the rice ration, another non-haem iron source (Banjong et al., 2003). The most commonly consumed food group at long-term refugee camps in Algeria, further, was the 'grains' group; again, this was a plant-based source of nutrients, including iron (Morseth et al., 2017).

The impact of unvaried, "cereal and legume-based" diets on iron status has been explored by Zimmermann *et al.* (2005) in Morocco. In this study, children who had participated in an iron fortification intervention and had achieved iron sufficiency were assessed for changes in iron status upon a return to their usual diets, which were characterised by high non-haem iron source food reliance on a background of low diet variety (Zimmermann et al., 2005). Iron source foods came predominantly from the 'cereals' group (57%) in the children's usual diets, and secondarily from the legumes group (13%) (Zimmermann et al., 2005). Meat source foods contributed only 9% of iron in these children's usual diets (Zimmermann et al., 2005). At the end of the study period, Hb and serum ferritin concentrations had decreased significantly and serum transferrin receptor concentration had increased, indicating significantly worsened biochemical iron status for the children upon resumption of their usual diets (Zimmermann et al., 2005). Anaemia prevalence reached 43% by the end of this period, where it had been 0% at baseline

(Zimmermann et al., 2005). The bioavailability of non-haem iron in these diets was also found to be very low (2%), and so, despite consuming adequate amounts of iron, adequate absorption could not be achieved (Zimmermann et al., 2005). This study highlights the significant impact non-haem iron bioavailability can have on biochemical iron status, irrespective of the consumption of adequate amounts of dietary iron. It also demonstrates that, in contexts of high reliance on non-haem sources of iron, as is the case in resource-poor, food insecure contexts, diversifying diets must be accompanied by increasing non-haem iron bioavailability in order to impact biochemical iron status significantly.

Non-haem iron absorption inhibitor consumption has been found to be associated with biochemical iron status in resource-poor regions, including at refugee camps. Kemmer *et al.* (2003) found that daily consumption of non-haem iron inhibitors (e.g. phytates and polyphenols) predicted anaemia status for Burmese refugee infants at Thai camps. Sirdah (2008) similarly found that regular consumption of tea, a non-haem iron absorption inhibitor, was associated with reduced Hb concentration for Palestinian adolescents and young adults (aged 14-22 y) resident at, and outside, long-term camps in Gaza. The consumption of tea with, or directly after, meals was also found to be associated with reduced Hb concentration (Sirdah, 2010). The study also examined associations between regular consumption of non-haem iron absorption enhancers, i.e. citrus fruits, and Hb concentration. Hb concentration was found to be significantly higher for both females and males who consumed citrus fruits frequently compared to those who did not (Sirdah, 2010). Both frequent consumption of meat (i.e. at least twice a week) and frequent consumption of a non-haem iron food source – leafy greens – were also found to be independently associated with significantly higher Hb concentration when compared to infrequent consumption (2-3 times per month for meat consumption) (Sirdah, 2010). The majority of those consuming meat in the study population consumed it 2-3 times monthly rather than twice a week (460 compared to 290) (Sirdah, 2010). By contrast, proportions of consumers of leafy greens and citrus fruits were larger for the group consuming them frequently rather than infrequently (866 compared to 129, and 597 compared to 267, respectively) (Sirdah, 2010). The findings of this study further illustrate the significant role non-haem iron source foods play in the diets of residents and refugees in resource-poor, food insecure contexts, as well as the relative impacts enhancers and inhibitors of non-haem iron absorption can have for biochemical iron status.

Summary points

- While diet diversification is associated with increased dietary micronutrient adequacy, which can contribute to attaining dietary iron adequacy, the bioavailability of dietary iron additionally impacts whether iron consumed in sufficient amounts is also available for absorption;
- Dietary iron is categorised as either haem or non-haem. Non-haem iron is less bioavailable than haem iron;
- Non-haem iron bioavailability is strongly impacted by the relative contents of various enhancers (e.g. vitamin C and meat) and inhibitors (e.g. phytates and polyphenols) of its absorption also present in a meal;
- Increased co-consumption of non-haem iron absorption enhancers and decreased co-consumption of inhibitors have each been demonstrated to be associated with improved biochemical iron status for resource-poor, food insecure populations reliant on plant-based foods to meet the bulk of their dietary nutrient needs;
- The reliance of resource-poor, food insecure populations on plant-based food sources to meet the majority of micronutrient and iron needs combined with the comparatively reduced bioavailability of non-haem iron puts these populations at increased risk of biochemical iron deficiency and associated anaemia, even when adequate amounts of iron are present in the diet.

Associated study aims

To date, no comprehensive plant-based meal list that contains detail on food components and preparation practices relevant for characterising non-haem iron bioavailability has been prepared for a Palestinian refugee camp community in Lebanon. To this end, this study aimed to collect data on plant-based meals prepared in the households of participating adolescents. Further, this study aimed to outline usual ingredients incorporated into reported meals and usual preparation methods thereof, with a view to identifying potential avenues for optimising non-haem iron bioavailability in these meals at the household level.

Associated research questions

Research question 6: *What plant foods are prepared in adolescent households at the camp?*

Research question 7: *How are plant-food contributors of non-haem iron usually prepared and consumed in these households?*

Associated research hypotheses

Food preparers at the Beddawi camp were expected to be incorporating a range of non-haem iron bioavailability reduction and enhancement practices into their routine preparation of plant foods. These discrepant practices were additionally expected to provide opportunities for developing appropriate, community-based interventions that may influence the iron status of adolescents in these households positively.

CHAPTER THREE: STUDY CONTEXT

In this chapter, the general sociopolitical framework within which Palestinian refugees live and work in Lebanon is set out, in order to highlight the constrained civil and civic rights conditions under which nutritional vulnerability, the primary focus of this thesis, proliferates and persists intergenerationally for Palestinian refugees in Lebanon. Palestinian legal status in Lebanon is described first. This is followed by an outline of the socioeconomic outcomes of these legal vulnerabilities for Palestinian refugees in Lebanon. The chapter closes with a description of UNRWA camps in Lebanon – the key spaces of residence and service provision for Palestinian refugees therein – with additional reference to the Beddawi refugee camp in the country's north – the camp at which this study was conducted.

Palestinian legal status in Lebanon

Lebanon was one of several Arab states to receive displaced Palestinians during and after the conflicts that led to the establishment of an Israeli state in 1948. Palestinian refugees make up a unique group. They are subject to a combination of evolving host-country, regional and international legal instruments. A handful of key UN General Assembly (UNGA) resolutions specifically address Palestinian refugees. These led to the establishment of UN protection and relief organisations with mandates that deal with Palestinian refugees separately to other refugee groups. While this setup was intended to ensure adequate focus on this refugee group, for which the UN acknowledged responsibility due to its role in sanctioning the conditions that led to mass Palestinian displacement, the separation of protection and assistance functions, and the failure of the UN organisation tasked with the former to fulfil its mandate, opened Palestinian refugees up to ambiguous legal status and, subsequently, to myriad rights abuses across the regions to which they fled (Takkenberg, 1998). Without this protection, the legal status of Palestinian refugees became dependent on host country refugee policy and relevant regional and international conventions to which the host country is party. In Lebanon, refugee policy is poorly defined (Janmyr, 2017; Al-Natour, 1997). Further, Lebanon has not acceded to any international conventions protecting the rights of refugees or stateless persons (Janmyr, 2017). These conditions, along with the Lebanese government's stance on long-term Palestinian refugee responsibility, which it places with Israel and the international community, cultivate a local environment wherein Palestinian marginalisation is routine and rights abuses against Palestinians in Lebanon defy legal definition and remedy (Al-Natour, 1997; Takkenberg, 1998).

UNGA Resolution 194 (III)

UNGA resolution 194 (III) plays a key role in guiding the treatment of Palestinian refugees internationally and domestically in host country contexts; it underpins any discussion of the search for durable solutions (i.e. voluntary repatriation, host country integration or resettlement) to their displacement. This resolution is commonly invoked, particularly its eleventh clause, to refer to the Palestinian 'right of return'. Interpretation of the clause has been – and remains – a source of contention among the major political and humanitarian actors involved with the welfare of Palestinian refugees (i.e. relevant government and non-governmental organisations [NGOs] in Israel and the Palestinian territories, and the Arab and North African states to which Palestinian refugees fled upon displacement). This clause[1] outlines an expectation that Palestinian refugees wishing to return to the areas from which they were displaced will be allowed to do so or that they will be compensated for lost livelihood and property as a result of displacement in lieu of return. It has been cited in Lebanon to justify postponing indefinitely the awarding of citizen rights to its Palestinian refugees while their repatriation or resettlement is negotiated – the implication being that, should such rights be awarded, this would amount to the resettlement of Palestinian refugees in Lebanon, which would undermine the need for implementation of the eleventh clause, absolving Israeli and international (including UN) parties of the responsibility of Palestinian refugees that the Lebanese government places squarely with them (Haddad, 2004; Al-Natour, 1997). This contention makes up one part of the political complexity that interferes with the process of formalising the legal status of Palestinian refugees in Lebanon. Their exclusion from the mandate of the UN High Commissioner for Refugees (UNHCR) is another key part.

Palestinian refugees and the UNHCR

The UNHCR is the UN body responsible for ensuring the protection of refugee rights internationally through legal advocacy (protection) and humanitarian relief (assistance). Palestinian refugees are excluded from this mandate on the basis that they have membership with other UN organisations that are tasked with their protection and assistance. The two UN bodies established to ensure Palestinian refugee protection and assistance during their

[1] "*The General Assembly, Having considered further* the situation in Palestine… 11. *Resolves* that the refugees wishing to return to their homes and live at peace with their neighbours should be permitted to do so at the earliest practicable date, and that compensation should be paid for the property of those choosing not to return and for loss of or damage to property which, under principles of international law or in equity, should be made good by the Governments or authorities responsible;

Instructs the Conciliation Commission to facilitate the repatriation, resettlement and economic and social rehabilitation of the refugees and the payment of compensation, and to maintain close relations with the Director of the United Nations Relief for Palestine Refugees and, through him, with the appropriate organs and agencies of the United Nations…" (General Assembly resolution 194(III), *Palestine – Progress Report of the United Nations Mediator*, A/RES/194 (III) (11 December 1948), available from: https://undocs.org/en/A/RES/194(III)).

displacement were the UN Conciliation Commission for Palestine (UNCCP) and the UNRWA, respectively. The UNCCP was established as part of UNGA resolution 194 (III); it was the UN body set up to see out the recommendations set out in the resolution and to mediate between involved parties to reach a 'final settlement' regarding the outstanding points of contention for Palestinians following the establishment of the Israeli state (Takkenberg, 1998). UNCCP establishment (December 1948) predated the establishment of the UNHCR (December 1949) and was intended as a legal protection body for Palestinians during the post-1948 interim period, over the course of which the status of Palestine, Israel and each state's respective citizens was to be decided (Akram, 2002; Takkenberg, 1998). The UN body established to provide healthcare and education services for Palestinian refugees in and around former Mandate Palestine over this period was the UNRWA. It was established a few days after the UNHCR but began its operations earlier (statutes relating to the UNHCR mandate were adopted a year later). The UNRWA was intended, and remains, the relief body central to Palestinian refugee humanitarian assistance in this now-extended interim period. The UNCCP was unable to fulfil its mandate and was informally relieved of its protection function, though no like body has replaced it (Takkenberg, 1998).

Although the outlined setup was intended as adequate, targeted consideration of the matter of Palestinian displacement, the separation of protection and assistance mandates and the practical failure of the body tasked with the former to fulfil its mandate put Palestinian refugees, instead, in a uniquely vulnerable, ambiguous legal position (Akram, 2002).

The 1951 Refugee Convention and 1967 Protocol

As part of the UNHCR mandate, protection and assistance functions for refugees are combined and implemented in line with the Convention Relating to the Status of Refugees (the '1951 Convention' hereafter). As per the 1951 Convention's guidelines, refugees already registered with other UN bodies (tacitly understood to mean Palestinian refugees registered with the UNRWA) are not eligible for its services (Takkenberg, 1998; Akram, 2002). Later, a Protocol (the '1967 Protocol' hereafter) was added to broaden the scope of the 1951 Convention's mandate, though Palestinian refugees registered with the UNRWA remained ineligible for its assistance. The 1951 Convention and 1967 Protocol set out comprehensive details regarding the expected minimal treatment of refugees in countries that had adopted the original 1951 Convention or the 1967 Protocol (signatories to the 1967 Protocol become automatically bound by the statutes in the 1951 Convention) (Takkenberg, 1998).

Among the difficulties encountered by Palestinian refugees in Lebanon is the lack of a standardised framework for their treatment along the lines outlined in the 1951 Convention and 1967 Protocol. This is exacerbated by the ambiguity of definitions applied to Palestinian refugees in the international space (Akram, 2002). While the 1951 Convention explicitly defines the term 'refugee', delineating a definition for Palestinian refugeehood has been an evolving process (Akram, 2002). The definition generally accepted for application to Palestinian refugees is one born of UNRWA operational activities[2]; it has been a 'working' definition since the UNRWA began its operations and has not been formally adopted by the bodies responsible for Palestinian refugee welfare, though it is practically invoked and so, implicitly accepted (Takkenberg, 1998).

Outside of international legal protection initiatives, refugees become subject to regional and host country policies during their displacement. In Lebanon – one of the UNRWA's major areas of operation – Palestinian refugee legal status is regulated in this way. As Lebanon is not a signatory to the 1951 Convention nor to the 1967 Protocol, this is also the case for Palestinian refugees in Lebanon not registered with the UNRWA. As such, all Palestinians in Lebanon are left with limited recourse to legal protection, though registered refugees are provided with education, vocational training, healthcare and economic support services through the UNRWA (UNRWA, 2021).

Regional protections: The 1965 Casablanca Protocol

Lebanese treatment of Palestinians is governed by one regional instrument – the 1965 Casablanca Protocol (the 'Casablanca Protocol' hereafter). The Casablanca Protocol was prepared to outline explicitly Palestinian (refugee and other) legal rights during their displacement in Arab states, and covers key employment, property ownership and exit/re-entry considerations. Lebanon ratified this Protocol, though it did so with reservations pertaining to Palestinian employment, outlining that prevailing local economic conditions would dictate the degree to which Palestinians could engage in work as stipulated in the instrument (Takkenberg, 1998). In comparison to other non-Palestinian states hosting large numbers of Palestinians since 1948 (e.g. Jordan and Syria), Palestinian refugees suffer the most restrictive and ambiguous rights framework in Lebanon (Haddad, 2004; Takkenberg, 1998).

[2] The UNRWA definition is as follows: "Palestine refugees are persons whose normal place of residence was Palestine during the period 1 June 1946 to 15 May 1948, and who lost both home and means of livelihood as a result of the 1948 conflict." It is utilised to evaluate eligibility for registration with UNRWA for the provision of its relief services, and so this definition excludes displaced Palestinians who do not meet its aid eligibility criteria (Akram, 2002). Children born to Palestinian fathers who meet these criteria, are also eligible for UNRWA assistance. These refugees are explicitly referred to as "Palestine" refugees. Displaced Palestinians who do not meet the criteria for UNRWA assistance, or those Palestinian refugees produced during subsequent waves of conflict in the region, then, meet with more impediments to having their refugeehood acknowledged and defined.

Lebanese refugee policy

Definitional ambiguities in the international space are retained in Lebanese domestic policy relating to Palestinian legal status. Palestinian refugees are effectively categorised as a subgroup of 'foreigners' in Lebanon (Janmyr, 2017; Al-Natour, 1997). As such, they are bound by policies that restrict their rights to work and own property in Lebanon and to exit and re-enter its borders in ways that are inconsistent with international standards for treatment of refugees and stateless persons (Al-Natour, 1997).

Palestinians in Lebanon are required, like other foreigners, to acquire a work permit to engage in professional employment (i.e. skilled labour). They are also bound by a principle of reciprocity, which dictates their eligibility to join professional associations, upon which permissions to participate in these professions is predicated (Al-Natour, 1997). This reciprocity principle informs other dealings with foreigners in Lebanon and outlines that employment and other rights will be extended to foreigners in Lebanon to the same degree as would be afforded Lebanese nationals in the countries of which these foreigners are citizens (Knudsen, 2009; Al-Natour, 1997). Stateless persons are, therefore, at a disadvantage in Lebanon, as they are foreigners without citizenship in a recognised state. Although exceptions have been applied haphazardly to Palestinians in view of their unique foreigner status, this reciprocity principle (along with the necessity of obtaining a work permit) has constrained their participation in various sectors of the workforce – sectors that would afford them benefits and minimal protections they otherwise miss out on when employed in unregulated, unskilled labour sectors (e.g. construction and agriculture) (Suleiman, 2006; Haddad, 2004).

In 1969, the Palestine Liberation Organization (PLO) and the Lebanese government negotiated an agreement – the Cairo Agreement – to regulate the Palestinian presence in Lebanon. This agreement addressed employment and mobility dimensions of the Palestinian stay in Lebanon, in recognition of the continued international barriers preventing UNGA resolution 194 (III) articles from being implemented and the associated persistence of displacement for Palestinians in Lebanon. The Cairo Agreement also granted the PLO permission to conduct its military resistance activities against Israel from Lebanese land, with conditions. In the decades that followed, this resistance and a range of existing local contentions led to the Lebanese civil war (1975-1990) (Weighill, 1997; El Khazen, 1997). The Cairo Agreement was abrogated formally and completely in 1987 (Takkenberg, 1998). By the end of the civil war, the legal and social position of Palestinians in Lebanon had deteriorated dramatically. A dimension of volatility and mistrust was added to the already sensitive relationship between Palestinians and Lebanese,

further undermining the formalisation of Palestinian legal status in Lebanon (Haddad, 2004; Weighill, 1997; El Khazen, 1997).

Granting Palestinians similar rights to Lebanese nationals has additionally been understood to be the natural precursor to their permanent integration in Lebanon (Meier, 2010; Knudsen, 2009). Resistance to the formalisation of Palestinian legal status in Lebanon is, then, also related to a rejection of the responsibility for absorbing these refugees permanently; not only on the grounds of upholding article 11 of UNGA resolution 194 (III), but also because of the local political implications of the demographic shift Palestinian integration would mean in Lebanon (Haddad, 2004; Weighill, 1997). Lebanon's government runs as a confessional consociationalism, i.e. positions are allocated in line with religious sect membership, and religious demographics are ostensibly represented in these assignments. As such, the permanent settlement of such a large proportion of a demographic already present in Lebanon (i.e. Sunni Muslims), one that already holds significant political influence in government, is viewed by certain parties (e.g. Maronite Christian and Shi'i Muslim) as a threat to the tenuous confessional balance in the country (Meier, 2010; Haddad, 2004).

Palestinian socioeconomic status in Lebanon

Access to employment is curtailed for Palestinians in Lebanon as a result of the haphazard legal status applied to them. This results in compromised socioeconomic outcomes for these communities. Participation in the Lebanese labour force has been unstable for Palestinians since their initial displacement, with access to employment changing in response to continually shifting political processes, regionally and locally.

Lebanese opposition to formalising Palestinian legal status has led to Palestinians being designated a modified foreigner-status in Lebanon. One major way this impacts Palestinian well-being is through employment. In the immediate aftermath of their displacement to Lebanon, Palestinians lived off the financial reserves they had accumulated at home, assuming that their exodus was temporary and that they would soon return to Palestine, their homes and jobs (Sayigh, 1978). As their situation became more protracted, and as their living conditions worsened, Palestinians in Lebanon initially found work as labourers and domestic workers. The conditions for Palestinians in Lebanon at this time were dire. The establishment of the UNRWA in 1949 alleviated this somewhat, offering services denied to Palestinians by the host-country government. As part of the UNRWA mandate, education and employment opportunities opened up for Palestinians, and those eligible for registration as refugees with UNRWA received food and financial aid and free healthcare services.

Surveys have been carried out intermittently in Lebanon to assess the vulnerability of Palestinian refugees resident therein. These studies have assessed socioeconomic outcomes, living conditions and a range of health indicators. They have demonstrated that the social exclusion and legal ambiguity applied to Palestinians in Lebanon produce long-term poverty, which impacts education and employment trajectories, quality housing access and health and food security outcomes negatively (Chaaban et al., 2010; Habib et al., 2014a; UNRWA & AUB, 2015).

Poverty, expressed as insufficient income and assets to cover needs and protect against economic shocks (e.g. sudden illness of household wage earner), is high across Palestinian refugee communities in Lebanon (Chaaban et al., 2010; UNRWA & AUB, 2015). Access to mediating forces (e.g. continued education and health services) is also impeded, compounding the negative consequences of material poverty. Two UNRWA-commissioned surveys carried out in partnership with the American University of Beirut (AUB), five years apart, have demonstrated the persistence of poverty in Palestinian communities in Lebanon, characterising poverty along both 'money-metric' (i.e. income, expenditure and assets) and 'capabilities'[3] or multi-dimensional lines (i.e. educational attainment, housing quality and health) (Chaaban et al., 2010; UNRWA & AUB, 2015). These reports also outline general relationships between demographic factors (e.g. gender, age, household size, camp compared to gathering residence and governorate association) and socioeconomic status, highlighting the impact of legal and social marginalisation on employment access and quality and, subsequently, on access to key services that contribute to general welfare and socioeconomic participation.

Across the two reports, the general incidence of poverty remained consistent, though there were shifts in the distribution and depth of poverty for the participating communities. Both studies gathered data that were nationally representative. The reports drew out features of general and extreme poverty for Palestinian refugees in Lebanon at the household level. Household poverty incidence using money-metric measures was 66.4% in 2010 and 65.2% in 2015. Extreme poverty incidence was 6.6% and 3.1% for 2010 and 2015, respectively. While overall poverty incidence did not change significantly over this period, its distribution did. In 2010, Tyre and Saida in the south of Lebanon experienced the highest poverty (79.2%) and extreme poverty (9.8%) rates, respectively (Chaaban et al., 2010); while in 2015, the highest poverty and extreme poverty rates

[3] Money-metric outcomes measure poverty through income, assets and expenditure assessment; while capabilities outcomes measure deprivation through an assessment of education, health and food access and housing quality that indicate a promotion of social and economic participation within a community (Chaaban et al., 2010).

were both experienced in the north of Lebanon (72.3% and 4.1%, respectively) (UNRWA & AUB, 2015).

Deprivation indices were also calculated to outline capabilities features of the socioeconomic landscape for the Palestinian refugee communities assessed; these included composite scores for education, living conditions and health outcomes. In both reports, these indices of multi-dimensional poverty (calculated differently[4]) correlated well with money-metric measures of poverty (Chaaban et al., 2010; UNRWA & AUB, 2015). In 2010, overall deprivation (i.e. general and extreme deprivation across camps and gatherings) was at least 40% (Chaaban et al., 2010). In 2015, deprivation incidence represented by a multi-dimensional poverty index was 24%, with severe multi-dimensional poverty incidence at 2.1%.[3] In both studies, poverty and deprivation incidence were higher in camps than in gatherings and for younger groups (i.e. older children, adolescents and young adults). Adolescents aged 15-19 y experienced the highest poverty rates of all age groups; 72.9% were living in poverty and 9.0% in extreme poverty in 2010 (Chaaban et al., 2010), and 74.5% and 5.1% in 2015 (UNRWA & AUB, 2015).

These outcomes demonstrate the persistent negative implications for Palestinian refugees in Lebanon resulting from their ambiguous legal status and the political stalemates that undermine the realisation of proposed durable solutions in the case of Palestinians. The high poverty prevalence across Palestinian communities in Lebanon is perpetuated despite essential service provision by the UNRWA and a host of local and international NGOs over decades of Palestinian displacement, additionally demonstrating the inadequacy of existing measures for meeting the fundamental needs of Palestinian refugees resident therein.

UNRWA camps in Lebanon

Overview

UNRWA camps were initially established in Lebanon from 1949 and through the 1950s. Informal settlements, army barracks and convents utilised by Palestinian and other refugees through waves of regional and local conflict were also converted over this time, and through the 1960s

[4] In 2010, a deprivation index was calculated through principal component analysis (PCA), which acted as a proxy for 'multi-dimensional poverty' that included capabilities outcomes to fill-out the picture of money-metric poverty more fully. The capabilities outcomes included in the index were health, food security, education access, employment access, housing quality and essential household asset ownership (Chaaban et al., 2010). For this index, data are continuous and lower scores indicate more severe deprivation (Vyas & Kumaranayake, 2006). In 2015, multi-dimensional poverty was calculated as an average of 3 scores weighted equally to produce a value between 0 and 1, each representing composite education (enrolment and attainment), health (food security) and living standards (water, sanitation, housing features and essential assets ownership) scores (UNRWA & AUB, 2015). For this index, a score greater than 0.3 indicates multi-dimensional poverty and a score greater than 0.5 indicates severe multi-dimensional poverty.

and 1980s, to produce the 12 UNRWA camps currently in operation across Lebanon (ANERA, 2012). These camps vary in size, housing from as few as 627 UNRWA-registered refugees (Mar Elias in Beirut, Central Lebanon) to 50,309 (Ein el-Helweh in Saida, South Lebanon) [numbers as of 2012] (ANERA, 2012). The camps are overcrowded spaces with deteriorating infrastructure that has been built haphazardly and that cannot be properly restored or maintained given restrictions placed on camp development by the Lebanese government (ANERA, 2012; Davey & Maziliauskas, 2003). Such conditions have given rise to a host of sanitation and safety issues (Davey & Maziliauskas, 2003). These challenges are exacerbated and further protracted by the inconsistent governance structures in place within UNRWA camps, whereby camps are administered and surveilled through unstructured, uneasy and inconsistent input from Lebanese authorities and various Palestinian factions (Hanafi & Long, 2010).

The Beddawi refugee camp

The Beddawi refugee camp is one of two northern camps in Lebanon and was established in 1955. The camp is similar to other UNRWA camps across Lebanon in that it is overcrowded, its infrastructure is poorly maintained, and its governance structures are poorly defined. It has, however, experienced relatively less conflict compared to other camps (e.g. Nahr el-Bared), and so entry into and exit from the camp are not as tightly regulated by Lebanese authorities (e.g. permits are not required to enter the camp [as of 2018]).

Numbers of residents at UNRWA camps are uncertain, and this is also the case for the Beddawi camp. Lower estimates of its population size suggest that 7,866 Palestinian refugees registered with UNRWA are resident at the camp (ANERA, 2012), while higher estimates put it at as many as 16,000 (Tiltnes, 2007). As with population estimates across Lebanon more generally, these numbers do not capture the full population picture; the camp has absorbed waves of additional refugees in the past decade and a half, including internally displaced Palestinians from the Nahr el-Bared camp subsequent to a major 2007 conflict, as well as Palestinian refugees from Syria and Syrian refugees fleeing the Syrian civil war. UNRWA camps are also home to Palestinians not registered with the organisation, further adding to the ambiguity surrounding camp population sizes. As with other camps, life at the Beddawi camp is characterised by high levels of poverty, which undermine social, educational and economic opportunity for its residents (Al-Hroub, 2015; Hanafi et al., 2012).

Concluding summary

The legal status of Palestinians in Lebanon remains subject to complexities and ambiguities that reduce Palestinian access to the Lebanese labour market, perpetuating a state of poverty for

Palestinian refugees, especially those in camps. While Palestinians and Lebanese have worked to renegotiate aspects of Palestinian rights in Lebanon during the seven decades of their displacement, Palestinians remain limited in their employment, property ownership and mobility options, and have ill-defined recourse to legal determination and associated access to remedies against rights abuses. This marginalisation is a product of:

(i) ambiguous international and regional definitions of Palestinian refugeehood;
(ii) discrepancies in UN frameworks for protecting Palestinian refugee rights while also ensuring humanitarian assistance during their displacement; and
(iii) the sensitive relationship between Palestinians and Lebanese in Lebanon, born of a complex history of fluctuations in support and conflict between these communities.

One result of the socioeconomic impacts of these conditions is high levels of poverty and associated food insecurity, which increases the nutritional vulnerability of Palestinian refugees living long-term in Lebanese camps (Ghattas et al., 2015). These vulnerabilities persist despite UNRWA's provision of a host of essential services across these camps. Adolescents, then, with their disproportionately high rates of poverty in these camps, comprise a particularly vulnerable group, and the implications of these conditions are investigated further in this study at one Lebanese camp – the Beddawi camp.

CHAPTER FOUR: QUANTITATIVE METHODS AND MIXED-METHODS DATA COLLECTION

The methodological approach used in this research is outlined in this chapter, as are the specific quantitative methods applied. An embedded mixed-methods approach was used to collect and analyse data. The methodological framework used to guide analyses is outlined in this chapter, as are the analyses applied to describe the quantitative data collected in this study. The methods used to analyse this study's qualitative data are described in **Chapter six: Qualitative methods**. A rationalisation of the suitability of an embedded mixed-methods approach for this research is outlined first in this chapter. Next, the data collection methods undertaken for this study for both quantitative and qualitative data are presented, followed by a detailed outline of the study's quantitative analyses.

Embedded mixed-methods study design

Background

Mixed-methods research involves the collection, analysis and interpretation of both quantitative and qualitative data (Creswell, 2006; Tariq & Woodman, 2013). The major goal of mixed-methods research is to offset the philosophical and practical limitations of either quantitative or qualitative methods, by using one as a complementary research tool to the other (Ivankova et al., 2006; Turner et al., 2017). Several variations of this type of research have been developed, given the many ways that quantitative and qualitative methods may be applied and the degree to which they are integrated, to explore research questions or aspects thereof. Creswell (2006) outlines four broad types of mixed-methods research design into which these variations may be organised: triangulation, embedded, explanatory and exploratory.

The study described in this thesis employed an embedded mixed-methods design, which involves one research arm playing a supporting, yet integral, role within the context of the other (Creswell, 2006). Quantitative and qualitative data were collected at the same time during a single phase of data collection. Analysis and interpretation of the qualitative data complemented and supported the exploration of additional aspects of the broader research question, which was predominantly addressed through engagement with the quantitative data. The quantitative methods were applied to provide a framework within which to explore aspects of adolescent anaemia in relation to diet diversity and iron-linked plant source food use at the Beddawi refugee camp. Qualitative methods were used within this study to explore practices surrounding household plant source food preparation, as well as household food preparer (FP) valuation of these foods, in order to

respond to aspects of the research question that could not be described by the quantitative findings alone.

Embedded mixed-methods study design and community nutrition

The supplemental addition of qualitative to quantitative methods (or vice versa), which is characteristic of the embedded mixed-methods design type, allows for the development of nuance that would otherwise be hidden were one or the other applied alone (Meissner et al., 2011). In such a design, quantitative and qualitative methods are applied either in a single phase or in two phases to answer different aspects of a research question (Creswell, 2006). Study contexts in which this design type is suitable include, for example, situations where the uptake of a program is met with barriers despite its seeming applicability to a community issue, or where intractable negative outcomes (e.g. for health) are observed for certain groups and not for others in similar positions. The suitability of a mixed-methods approach in these contexts lies in its generation of quantitative data, which allows for the description and summarisation of outcome distributions, along with its concurrent production of qualitative data, which engages with perceptions, beliefs, attitudes and values that may offer insight into patterns within the distributions (Meissner et al., 2011). The embedded design, then, enables a researcher to respond to different aspects of a research question, i.e. to characterise a problem quantitatively, while also exploring views that may impact this characterisation within a community. Such insights as these produced through the embedded mixed-methods approach comprise valuable data for informing future research and program designs that seek to make sustainable impacts within communities experiencing long-term, discrepant economic and health burdens.

Embedded mixed-methods study design as applied to this research

The overarching research question for this study was: “What dietary factors may be harnessed to optimise iron status and mitigate anaemia risk for adolescent Palestinian refugees at the Beddawi camp in North Lebanon?” Data appropriate for responding to this question included quantitative data to characterise anaemia, iron-link dietary factors and plant source food use for participants, as well as qualitative data to explore plant source food valuation by FPs in these households. Qualitative methods were embedded within a largely quantitative study design, and allowed for the generation and analysis of complementary data appropriate for responding to a particular part of the research question, i.e. valuation of plant source foods by those preparing them in the household. (The data collection methods used in this study are detailed further below, as are the

analysis methods applied to the quantitative data. The qualitative data analysis undertaken for this study is detailed in **Chapter six: Qualitative methods**.)

Existing socioeconomic studies conducted across refugee camps in Lebanon characterise camps as having predominantly young populations (Chaaban et al., 2010; Tiltnes, 2007). Those aged 6-19 y have been identified as being disproportionately impacted by the poverty that is widespread in these camps (Chaaban et al., 2010; Tiltnes, 2007). These communities experience high rates of food insecurity and are at high risk of malnutrition and associated poor health (Ghattas et al., 2015; Habib et al., 2014b). At the time this study was being designed, no published dietary or nutrition data were available to accompany food security data for any long-term camps across Lebanon. This study remains the first to describe anaemia, dietary and nutritional status for refugees at the Beddawi refugee camp, though these have also recently been described for Palestinians at long-term central Lebanese camps (see Jamaluddine et al., 2020, 2022). Given the dearth of published data on anaemia and iron-linked dietary outcomes for Palestinian camp communities across Lebanon, a key goal within the quantitative part of this study was to generate and characterise anaemia and dietary outcomes of adolescents within a long-term Lebanese camp – here, the Beddawi refugee camp in North Lebanon.

Quantitative data collected included general demographic and anthropometric characteristics for both adolescents and household FPs (e.g. sex, age, household size, height and weight), Hb concentration and food recall data for adolescent participants only, and plant source food use and preparation data for FP participants only (detailed further in the **Data collection** section below). Qualitative data collected included perspectives on plant source food importance to FPs (also detailed further in the **Data collection** section below and in **Chapter six: Qualitative methods**).

Data collection

Data collection was undertaken at the Beddawi refugee camp in North Lebanon from August to September in 2018. Ethics approval for the study was obtained from the Human Ethics Committee at Massey University (Human Ethics Southern A Committee, Application SOA 17/27) in August of 2017. Informed written consent was also obtained from adolescent and FP participants upon their recruitment and ahead of their first interview sessions.

It was not possible to recruit participants through UNRWA schools at the Beddawi camp for this study. Additionally, only few contacts could be made in the camp from outside of Lebanon. As

such, convenience and snowball sampling were applied to recruit participants. Contact was initially made (from New Zealand) with two organisations in the camp: El-Enaya Medical Centre and El-Gawth El-Insaani Aid Organisation. Further recruitment took place through contacts made at each initial recruitment location. Parents of adolescents that met the age criteria (below) were approached by local staff, first at these two organisations and then at local youth, scout and women's groups, as additional contacts were made. Friends and relatives of participants or staff at these organisations also dropped in or contacted the primary investigator (PI) to discuss and organise participation in the study upon referral by those already participating.

Participants were adolescent girls and boys aged 10-19 y and the FP in their household, who was usually also the adolescent participant's mother. Adolescent-FP participant pairs attended interviews together. Where an FP could not attend, another relative (e.g. father or aunt) attended with the adolescent instead. Adolescents were recruited for the study if they were aged 10-19 y, had resided at the Beddawi Camp for at least 2 years, had no known intestinal absorption issues or iron-related pathologies, and were not taking iron supplements at the time of the study. FPs were recruited alongside adolescent participants.

Data collection comprised a maximum of three sessions, at which both adolescents and FPs were attendant. At Session 1 (i.e. initial sessions), data on the following were collected:

- Adolescent and FP demographic information,
- Adolescent Hb concentration,
- Adolescent and FP anthropometry,
- Adolescent 24-hr food recall,
- Household plant source food preparation,
- Household dark leafy green use, and
- Household food security.

Sessions 2 and 3 (i.e. follow-up sessions) involved the collection of additional adolescent 24-hr food recall data only. All data were collected through a structured interview instrument. The instrument was developed in English, and was then translated into Modern-Standard Arabic by a professional Lebanese translator, Rima Gabriel. The instrument went through a further adaptation during the first five interviews, wherein a local research assistant (Ahmad Salma) proficient in both Arabic and English adapted the interview further from Modern-Standard Arabic

to a conversational Lebanese dialect to maximise its comprehensibility for participants (see **Appendix I** for the English language version of the final instrument used). The PI and her research assistant completed 35 initial sessions together. A remaining 36 initial sessions were completed by the PI alone. Hand-written notes were taken during sessions by the researchers present. Sessions completed in person were also audio recorded where permission was given to do so.

Sample size

Sample size for the study was calculated using the following formula for prevalence estimates (Arya et al., 2012):

$$n = \frac{Z^2 \times P(1-P)}{d^2}$$

Where:

Z (CI of 90%) = 1.645

P (estimated prevalence) = 20%

d (precision) = 0.10

Given the selected parameters, n was calculated to be 43 participants. As anaemia prevalence was to be estimated for 3 groups (one female group and two male groups), this value was multiplied by 3, giving a total sample size of 129 participants. The study attrition rate was set at 20%, and so the final sample size required was 155. This sample size could not be achieved in the field, however, due to logistical challenges, including the holding up and eventual destruction, of biochemical test kits at airport Customs.

For this study, 67 FPs completed initial interview sessions partially or in full, as did 66 adolescents. Of the 66 adolescents who provided data, 18 completed two additional follow-ups, and 17 completed a single additional follow-up. All initial sessions were completed in person, as were 38 follow-up sessions. As some participants were unable to attend follow-up sessions in person, 15 of these follow-up sessions were completed over the phone, as per FP-participant preference. Those who withdrew either could not attend an initial session in person or changed their minds about participating.

Adolescent and FP demographic information

Adolescent demographic data collected were: sex, age, medication and supplementation regimen (if any), length of camp residence (in years) and school attendance and current grade (if in school). FP demographic data collected were: sex, age, medication and supplementation regimen (if any), length of camp residence (in years), relationship to adolescent participant, household size (i.e. total number of household members including FP, and number of household members < 18 y), grade reached upon school leaving, and grade spouse reached upon school leaving. These variables are summarised in **Table 2**.

Table 2: Summary of demographic variables for which data were collected (adolescent, food preparer [FP])

Adolescent	**FP**
Sex	Sex
Age	Age
Medication and supplementation regimen	Medication and supplementation regimen
Length of camp residence (y)	Length of camp residence (y)
School attendance	Relationship to adolescent participant
Current grade	Household size (total and < 18 y)
	Grade reached in schooling
	Grade spouse reached in schooling

Adolescent Hb concentration

Data on Hb concentration were collected for adolescent participants only. The HemoCue® Hb 201+ point-of-care instrument was used to analyse capillary blood samples from adolescents obtained through finger-prick. The HemoCue Hb 201+ has been validated for use in determining Hb concentration precisely and accurately in comparison to a variety of reference methods, including the international reference method for haemoglobin determination: the hemiglobincyanide method, which is the gold-standard method for haemoglobin determination (Bäck et al., 2004; CLSI, 2000).

Results indicating low Hb concentration for sex and age were taken to be indicative of anaemia, as per WHO 2011 criteria (see **Table 3**). Adolescents returning low Hb concentrations were referred to their usual doctor for follow-up.

Table 3: WHO 2011 Hb concentration cut-offs for anaemia (adolescents)

Sex, age	WHO 2011 Hb cut-off for anaemia
Females (10-19 y)	Hb < 120 g/L
Males < 15 y	Hb < 120 g/L
Males ≥ 15 y	Hb < 130 g/L

Pubertal status was also ascertained during interviews. Females were asked about menstruation onset to determine puberty status, while males were asked about notable changes to voice and body size to ascertain likely puberty onset. If males or accompanying family members reported notable changes to voice or body size of the participating adolescent, the adolescent was considered pubertal. Where this could not be determined for an adolescent, female or male, (e.g. where this question could not be asked or was overlooked during an interview, or where an uncertain answer was given) adolescent participants were designated as being pubertal if they were aged ≥ 15 y. Where pubertal status could not be determined during an interview and where adolescents were less than 15 y of age, puberty data were considered missing.

Adolescent and FP anthropometry

Anthropometric data collected for both adolescents and FPs comprised height and weight measurements. Heights were measured in duplicate using a portable wall stadiometer (*Seca 213*, measures to 0.1cm). Weights were measured in duplicate using an electronic digital flat scale (*Seca 803*, measures to 0.1kg). Duplicate readings were averaged to produce final height and weight measurements. These measurement tools were supplied by the AUB in consultation with Dr Lara Nasreddine and Mandy Taktouk of the university's Department of Nutrition and Food Sciences.

Adolescent 24-hr food recall

24-hr food recall data were collected for adolescents only. Adolescents were asked to report the foods and beverages they had consumed in the previous 24 hours, which were then taken down in writing by the researchers. FPs present at interviews provided help with probing and reporting when necessary. The 24-hr recall method, which relies on a participant's memory and food knowledge, has been shown to be valid for adolescents aged at least 10 y (Foster & Bradley, 2018; Rankin et al., 2010).

Data collected during 24-hr recall interviews included: the time a meal was consumed, the type of meal consumed (i.e. breakfast, lunch, dinner or snack), the place at which the meal was consumed, whether the meal was bought out or prepared at home, a meal's ingredients and method of preparation, and an estimate of the portion consumed by the adolescent. Meal ingredient and preparation details were predominantly provided by FPs during these interviews. A multiple-pass approach, which included repeated review of 24-hr recall reports to probe for beverages, snacks and fruits consumed, was used as this has been shown to minimise reporting omissions (Foster & Bradley, 2018). While additional recall days improves the validity of the 24-hr recall method for adolescents (Rankin et al., 2010), and while attempts were made to collect data across three separate days including through the use of phone interviews, practically this was not possible for all adolescent respondents. 35 adolescent respondents completed a repeated recall (i.e. 18 completed three separate 24-hr recalls, and 17 completed two separate recalls), while the remaining 31 completed a single recall only.

24-hr recall data were collected for use in calculating individual diet diversity scores for adolescents – an outcome associated with adolescent dietary and, in some cases, biochemical iron adequacy (Korkalo et al., 2017; Meng et al., 2018; Olumakaiye, 2013). Calculating a diet diversity score (DDS) involves the collection of data on food, beverage and supplement consumption. Data are then allocated a representative food group of a total possible number of food groups. The number of food groups appropriate for calculating the DDS and the consumed portion size required for a food to be counted as consumed vary. DDS was calculated in this study in accordance with the method outlined by the UN Food and Agriculture Organization (FAO) for the calculation of 'minimum dietary diversity for women' (MDD-W) (FAO, 2021).

This method was chosen, as the MDD-W has been validated for use as a proxy indicator of micronutrient adequacy, defined as adequacy across 11 micronutrients, including iron (FAO,

2021). This method uses 10 food groups to derive the MDD-W score (see **Table 4** in the **Quantitative data analysis** section below). A minimum of 15g of a reported food or beverage must be consumed in order for that food to contribute data to the score's calculation. While there is not currently a micronutrient adequacy indicator validated specifically for adolescent males 15 y or older, the MDD-W was used in this study, as it has been demonstrated to be appropriate for the female half of the sample, and also for the younger portion (male and female) of participants (Caswell et al., 2018). A detailed outline of MDD-W calculation in this study is given in the **Quantitative data analysis** section below.

Household plant source food preparation

Qualitative data on the methods used to prepare plant source foods in the household were collected from FPs only. This part of interviews was largely unstructured, and FPs were encouraged to recall the plant source foods they prepared most often in their households. The researchers asked after certain meals if FPs struggled to remember more than two or three meals on their own. FPs were also asked about ingredients in the reported foods, and the methods they used to prepare those foods. Additional questions were put to FPs if they mentioned a plant source food that contained iron, to determine whether the meal also included ingredients that had the capacity to enhance or inhibit its absorption. The methods for preparing these ingredients were also asked after, in order to identify any techniques used that had the capacity to promote either the enhancement or inhibition of any iron contained in the meal.

Key food sources of iron that were followed up on during interviews were: dried pulses and legumes; green beans, peas and okra; dark green leafy vegetables; and nuts. Key food sources of iron absorption enhancers were meat source foods, or those that contained vitamin C or other organic acids (Cook & Reddy, 2001; Hurrell et al., 2006; Salovaara et al., 2002; Siegenberg et al., 1991), and included: lemon, chilli or capsicum, radish, pickles and tomato. Key food sources of iron absorption inhibitors were those that contained phytates or polyphenols (Hurrell et al., 1999, 2003; Minihane & Rimbach, 2002), and included: dried pulses and legumes, pomegranate molasses and tahini. The key method followed up on due to its implication in reducing the phytate content of iron source foods was: soaking dried pulses and legumes (Gibson et al., 2006). The key methods followed up on due to their implication in minimising vitamin C destruction in foods were: sautéing or blanching of fresh vegetables and vitamin C additions at the end of food preparation (Igwemmar et al., 2013; Somsub et al., 2008).

Household dark leafy green use

Data were also collected for a subcategory of plant source foods – dark leafy greens – again, from FP participants only. Additional questions on the frequency of household use of dark leafy greens, both wild and cultivated, were included in the interview instrument after the open-ended plant source food preparation section in the form of a food frequency questionnaire (FFQ) (see **Appendix I**). This follow-up section provided a reference list of dark leafy greens, including some edible wild plants, that each participant was asked about. This list also served to aid FPs in recalling further plant source foods in use in their households. The dark leafy greens discussed further in interviews additionally included edible wild plants.

Household food security

Data on broad aspects of household food security were collected in the last part of initial interviews from FPs only. Participants were asked about the availability of food in their households, whether they received organisational aid (e.g. in the form of food baskets or cash assistance), and the number of people contributing financially to their household. These questions were designed to capture two key aspects of food security as defined at the UN FAO World Food Summit in 1996, which describes food security as a state where: "…people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life." The two key aspects explored in this part of interviews were: [1] access at all times to adequate quantities of food to meet household member needs, and [2] access at all times to the foods preferred in the household. An additional question about the reception of aid was included to capture a key dimension of food security for the aid-dependency context. Food security questions included in the questionnaire were reviewed by Dr Jane Coad ahead of their finalisation.

Households were designated as food insecure if FPs reported any degree of deficit with reference to food quantity or preference (i.e. where FPs reported that enough food or foods preferred by household members were "Sometimes unavailable" or "Often unavailable"), or if they reported receiving aid. Households were designated as food secure if FPs reported "Always available" for foods in sufficient quantity to meet household member needs and preferences, alongside a report of not being an aid recipient.

Quantitative data analysis

Statistical analyses were performed using *R* software (RStudio 2021.09.0 version). Data were tested for normality using the Shapiro-Wilk test. Summary statistics were calculated for adolescent and household demographic and anthropometric data, adolescent Hb concentrations, and anaemia prevalence and diet diversity outcomes. Data were reported as mean [standard deviation (sd)] for normally distributed data, and median [interquartile range (IQR), range] for non-normally distributed data. Proportions were reported as percentages. Group differences for normally distributed data were analysed using independent *t*-tests. The Wilcoxon Rank Sum test was used to compare group differences for non-normally distributed data. Missing data were handled through pairwise deletion; as such, sample sizes vary for different analyses in accordance with data availability for the variables under analysis.

Adolescent and FP demographic information

Adolescent and FP demographic information were reported with respect to age (y), schooling outcomes, household size and food security.

Adolescent Hb concentration

Adolescent Hb outcomes were reported for all adolescents, females and males, and females and two male subgroups (i.e. < 15 y and ≥ 15 y). Only males were further split by age, as per sex and age groupings represented in the WHO 2011 anaemia reference cut-offs used to determine anaemia status in this study. Hb concentration and anaemia prevalence were also reported in the same way with reference to adolescent pubertal status. The proportion of adolescents with Hb outcomes at least 10 g/L higher than WHO 2011 cut-offs for their age and sex was also determined and reported as a percentage for each group.

Adolescent and FP anthropometry

Adolescent and FP anthropometric outcomes were reported in terms of weight (kg), height (cm) and body mass index (BMI) (kg/m^2). Height-for-age and BMI-for-age *z*-scores were generated for adolescents using WHO AnthroPlus software (v 1.0.4), which utilises WHO 2007 growth reference cut-offs for sex and age for children and adolescents aged 5-19 y. For adolescents, anthropometric outcomes were additionally summarised by sex and pubertal status. FP BMI outcomes were categorised based on the following WHO growth reference criteria for adults: *Underweight* (BMI <18.5 kg/m^2), *Normal weight* (BMI = 18.5-24.9 kg/m^2), *Overweight* (BMI = 25.0-29.9 kg/m^2), *Obese* (BMI > 30.0 kg/m^2).

Adolescent 24-hr food recall

A DDS was calculated for each adolescent that completed the 24-hr food recall section of initial sessions, using FAO 2021 guidelines for calculating the MDD-W. This score was then used as a proxy indicator of adolescent dietary micronutrient adequacy (DDS-M) (FAO, 2021). The MDD-W is referred to hereafter as 'DDS-M'.

Data for the DDS-M calculation may be collected through either a list-based method or an open-recall method (FAO, 2021). This study used an open-recall method (as outlined above in the **Data collection** section). Respondents provided food recall data without reference to a pre-prepared list of possible items, and these data were grouped post-data collection. The DDS-M is calculated from 10 possible food groups, which are aggregated from a larger set (see **Table 4**) (FAO, 2021).

*Table 4: Aggregated food groups used to calculate the DDS-M**

Food group number	Food group
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

* Table contents reproduced from Table 5, Section 4.1 of: FAO. 2021. *Minimum dietary diversity for women.* Rome. https://doi.org/10.4060/cb3434en

To calculate the DDS-M, a single point is assigned to a food group if at least one food belonging to that food group was consumed by the respondent in the preceding 24-hr period (FAO, 2021). While information on exact portion sizes need not be obtained from respondents to calculate the DDS-M, researchers must establish whether a portion of at least 15g (approximately 1 tablespoon) was consumed in order to assign a point to the associated food group (FAO, 2021). Establishing a 15g-minimum is also applicable where consumed foods include multiple ingredients (i.e. mixed dishes). Ingredients unlikely to be consumed from a mixed dish by an individual in a portion of at least 15g (e.g. spices) are to be excluded from the DDS-M calculation (FAO, 2021). Where there is uncertainty about meeting this 15g-minimum from provided responses, a conservative approach to inclusion is encouraged, i.e. the food in question is to be excluded (FAO, 2021).

A sample calculation of DDS-M as performed for individual food recalls in this study is provided below. **Table 5** summarises raw recall data for a participant in this study. An example of point assignment and associated rationales are presented in **Table 6** with reference to the provided recall.

Table 5: Sample summarised raw 24-hr food recall data collected using an open-recall method

Meal in day, time and location consumed	**Foods and beverages consumed**	**Approximate quantity consumed**	**Preparation details (if applicable)**
Breakfast 1 10:45am At school	Manᵓūshat zaᶜtar*	1 whole	Herb and olive oil pizza; baked
	Fruit juice – pineapple (*Bonjus*)	1 carton (180 mL)	N/A
	Instant noodles – chicken (*Indomie*)	1 packet (85g)	Consumed raw – not prepared
	Chips – salt and vinegar (*brand not known*)	1 small packet (~20g)	N/A

Meal in day, time and location consumed	Foods and beverages consumed	Approximate quantity consumed	Preparation details (if applicable)
Snack 2:30pm At home	Pistachios (raw)	1 handful	N/A
	Manᵓūshat jubnah*	0.5 whole	Cheese pizza; baked
Lunch 6:00pm At home	Faṭāiᵓr b'sabānikh	6 individual pastries	Pastries stuffed with spinach seasoned with salt, cumin, powdered chilli, lemon juice and olive oil; baked
	Plain yoghurt	Used as dip; amount unknown	N/A
Snack	None	N/A	N/A
Dinner	None	N/A	N/A
Snack	Peach	1 whole	N/A
Breakfast 2 9:30am At home	Kaᶜk*	1 whole	Savoury bread filled with cheese, capsicum, corn and tomato; baked
	Fruit juice – apple (*Bonjus*)	1 carton (180 mL)	N/A
Snack	None	N/A	N/A

* These foods were bought from street vendors

Table 6: Points assignment for DDS-M calculation from recall data in Table 5

Food group number	Food group	Point assignment, food
1	Grains, white roots and tubers, and plantains	1, manʿūshat zaʿtar
2	Pulses (beans, peas and lentils)	0
3	Nuts and seeds	1, raw pistachio[a]
4	Milk and milk products	1, cheese[b]
5	Meat, poultry and fish	0
6	Eggs	0
7	Dark green leafy vegetables	1, spinach
8	Other vitamin A-rich fruits and vegetables	0[c]
9	Other vegetables	0[d]
10	Other fruits	1, peach

[a] A handful of pistachios was considered to convert to at least 15g, so a point was assigned for this group.

[b] Cheese is a main ingredient in the kaʿk and the manʿūshat jubnah, so a point was assigned for this group.

[c] Although capsicum was consumed in the kaʿk, it is conventionally added in small quantities. As such, the 15g-minimum is in question and cannot be verified, so no point was assigned.

[d] Although tomato and corn were consumed in the kaʿk and both are included as foods contributing to the 'Other vegetables' food group in the FAO 2021 guidelines, they are conventionally added in small quantities. As with the capsicum, the 15g-minimum is in question and cannot be verified, so no point was assigned for this group.

In order to produce the final DDS-M, points assigned for individual food groups are summed. The final DDS-M for the above recall, then, is 5 (out of a possible 10).

As outlined in the FAO 2021 guidelines, the DDS-M is intended to be calculated from a single recall; however, multiple recalls were collected from adolescents in this study whenever possible in order to better characterise the usual diets of respondents over the study period. Where multiple recalls were available (see **Chapter five: Quantitative results** for a breakdown of recall numbers), a DDS-M was calculated for each 24-hr period, and the scores were averaged to produce the final DDS-M.

Adolescent DDS-M outcomes were reported as median [IQR, range] and mean [sd]. These data are also summarised in terms of the proportion of adolescents consuming from the 10 food groups contributing to the DDS-M calculation on a single recall day. Where multiple recalls were available for an adolescent, the first recall day only was used in food group consumption summaries.

Household plant source food preparation

Plant source foods reported during interviews with FPs were summarised in terms of all foods reported, foods reported by at least 20% of FP respondents, and foods reported by at least 20% of FP respondents that contained ≥ 1mg of non-haem iron per 100g. Plant-based meals reported by at least 20% of FPs and that contained ≥ 1mg of non-haem iron per 100g were described further in terms of meal ingredients and processing methods that may theoretically impact non-haem iron bioavailability.

Non-haem iron bioavailability may be reduced or increased by the presence of dietary components in an iron meal and by food processing techniques used in the meal's preparation. Phytic acid and phenolic compounds are key inhibitors of non-haem iron absorption (Cook et al., 1997; Hurrell et al., 1999, 2003; Tuntawiroon et al., 1991), while ascorbic acid and muscle tissue are key enhancers (Baech et al., 2003; Navas-Carretero et al., 2008; Teucher et al., 2004; Thankachan et al., 2008). Subsequent meal descriptions were made with reference to these key food components excepting polyphenols, as polyphenol content of the foods could not often be ascertained.[5] Food processing techniques that reduce or increase the contents of these food components also impact non-haem iron bioavailability. Techniques that reduce phytic acid content, for example, can enhance the bioavailability of iron in a meal, while techniques that destroy ascorbic acid in a meal can undermine its enhancing effects (Hurrell et al., 2003; Teucher et al., 2004). As such, these processing techniques were the focus of further description of meals with reference to non-haem iron absorption enhancement and inhibition.

Household dark leafy green use

Dark leafy green use was summarised in terms of FP report of household use of 1-14 of 14 possible dark leafy greens included in the FFQ, as well as a subset of 1-8 of 8 edible wild plants.

[5] While calcium has been shown to have an acute inhibitory effect on non-haem iron absorption in single-meal studies and where usual calcium intake is low, its impact on iron absorption from a whole diet over the long-term and where usual calcium intake is moderate or high has been shown to be more minor (Lynch, 2000). As such, calcium as an inhibitor of non-haem iron absorption was excluded from meal descriptions.

Household dark leafy green and edible wild plant use was also compared against adolescent Hb concentration and adolescent DDS-M using correlation tests.

Subsets of commonly used dark leafy greens and edible wild plants were also examined. Common use of these leafy greens on the FFQ was assigned if at least 20% of FPs also independently reported preparation of these greens in the open-ended food preparation section of interviews. This yielded 7 dark leafy greens and 5 edible wild plants in common use, which were then included on this basis for further analysis. A percentage of plants used by households of each the 7 dark leafy greens and 5 edible wild plants, as reported by FPs, was then compared against adolescent Hb concentration and DDS-M outcomes.

CHAPTER FIVE: QUANTITATIVE RESULTS

The quantitative results of this study are presented in this chapter. Adolescent and food preparer (FP) demographic data are presented first, followed by anthropometric outcomes for both groups. Adolescent Hb status and DDS-M outcomes are presented next. Data on household food preparation and dark leafy green use are presented last.

Adolescent and FP demographic information

The demographic data collected for participating adolescents and FPs are summarised in **Table 7**. Data were collected on age, schooling and household size. Adolescent age, and the highest grade reached by FP spouses were normally distributed. FP age, FP schooling and household size data were non-normal.

Adolescents

The mean age of participating adolescents was 14.4 y [sd = 1.88]. The proportion of all adolescents participating in schooling at the time of data collection was 86.4%. The proportion of female adolescents in schooling was higher than the proportion of males (90.0% of females, compared with 81.8% of males).

Food preparers

The median age of participating FPs was 40 y [IQR = 10.3, range = 30-58]. The median highest grade reached by FPs was 9 [3, 1-15]; the mean grade for FP spouses was 8 [4]. Household size was determined in terms of the total members and the number of members younger than 18 y, respectively. Median total household members was 5 [2, 2-10] and median household members younger than 18 y was 3 [3, 1-8]. Food insecurity was high in this group, with 71.2% of FPs reporting some degree of household food insecurity.

Table 7: Adolescent and FP demographic information summarised

Variable	n	Mean [standard deviation (sd)][a] / Median [interquartile range (IQR), range][b] / %[c]
Adolescent age (y)	66	14.4 [1.88][a]
Adolescents currently in schooling (all)	66	86.4[c]
Adolescents currently in schooling (female)	33	90.9[c]
Adolescents currently in schooling (male)	33	81.8[c]
FP age (y)	66	40 [10.3, 30-58][b]
Highest grade reached by FP	65	9 [3, 1-15][b]
Highest grade reached by spouse of FP	64	8 [4][a]
Total household members	67	5 [2, 2-10][b]
Household members <18 y	67	3 [3, 1-8][b]
Food insecure	59	71.2[c]

Adolescent Hb concentration

Hb concentration data were collected from all 66 participating adolescents. Adolescent Hb data were normally distributed. Mean Hb concentration (g/L) for participating adolescents is summarised in **Table 8**. Anaemia prevalence for participating adolescents is summarised in **Table 10**, as is the prevalence of adolescents returning Hb concentrations at least 10 g/L above the relevant WHO 2011 cut-offs for age and sex.

Mean Hb concentration for the entire adolescent group was 127.4 [13.1] g/L (see **Table 8**). Mean Hb concentration for females was 122.4 [11.5] g/L. For all males, mean Hb concentration was 132.4 [12.8] g/L. Mean Hb concentration was 127.3 [9.70] g/L for males < 15 y and 141.7 [12.7] g/L for males ≥ 15 y. Mean Hb concentration was significantly different between females and males (t = 3.39, df = 63.3, p-value = 0.001), between males < 15 y and males ≥ 15 y (t = 3.42, df = 18.4, p-value = 0.003), and between females (all) and males ≥ 15 y (t = 4.64, df = 18.0, p-value = 0.0002). Mean Hb concentration was not significantly different between females (all) and males < 15 y (t = 1.68, df = 47.8, p-value = 0.10).

Table 8: Mean Hb concentration (g/L) for adolescents by sex and age, n = 66

Group	n	Mean [sd] Hb (g/L)
All	66	127.4 [13.1]
Females (all) 10-19 y	33	122.4 [11.5]
Males (all) 10-19 y	33	132.4 [12.8]
Males <15 y	21	127.3 [9.70]
Males ≥15y	12	141.7 [12.7]

Mean Hb concentration with reference to pubertal status is summarised in **Table 9**. 19.7% of participating adolescents were pre-pubertal. Mean Hb concentration was 125.9 [8.39] g/L for the pre-pubertal group and 128.1 [14.6] g/L for the pubertal group; these differences were not significant (t = 0.67, df = 30.1, p-value = 0.51). Within the pubertal group, however, significant sex differences were found for mean Hb concentration, with males returning a significantly higher mean Hb concentration than females (t = 3.59, df = 44.7, p-value < 0.01).

Table 9: Adolescent Hb concentration (g/L) by pubertal status, n = 61

All adolescents	n	Mean [sd] Hb (g/L)
Pre-pubertal	12	125.9 [8.39]
Pubertal	47	128.1 [14.6]
Pubertal status uncertain*	2	N/A
Pubertal adolescents		
Females	22	120.9 [12.6]
Males	25	134.4 [13.3]

* Male pubertal status was more difficult to ascertain. Uncertainty here refers to ambiguity in report by the adolescent participant and/or accompanying adult of observed developmental changes associated with male pubertal onset (e.g. with reference to voice, body size and linear growth changes).

Anaemia prevalence

Anaemia prevalence for the entire adolescent group was 28.8% (see **Table 10**). Anaemia prevalence for females and males aged 10-19 y was 33.3% and 22.7%, respectively. Prevalence for males < 15 y was 28.6%, and for males ≥ 15 y prevalence was 16.7%. These anaemia prevalence outcomes were not significantly different between females and males (χ^2 = 0.296, df = 1, p-value = 0.59), nor between males < 15 y and all females (χ^2 = 0.004, df = 1, p-value = 0.95). Group comparisons that included the male ≥ 15 y group could not be done, as too few participants made up this subgroup.

Table 10: Anaemia prevalence and Hb concentration (g/L) adequacy for adolescents by sex and age

Adolescent group	**% anaemic**
All adolescents 10-19 y (n = 66)	28.8
Females 10-19 y (n = 33)	33.3
Males <15 y (n = 21)	28.6
Males ≥15 y (n = 12)	16.7

Anaemia prevalence with reference to pubertal status was also determined, and is summarised in **Table 11**. Anaemia prevalence was 16.7% for pre-pubertal adolescents and 29.8% for pubertal adolescents. Anaemia prevalence was further delineated by sex within the pubertal group, and was found to be 36.4% for females and 24.0% for males. A comparison test for anaemia prevalence across these groups could not be performed, as too few observations made up the respective puberty subgroups.

*Table 11: Anaemia prevalence by pubertal status, n = 59**

Puberty group	% anaemic
Pre-pubertal adolescents (n = 12)	16.7
Pubertal adolescents (n = 47)	29.8
Pubertal females (n = 22)	36.4
Pubertal males (n = 25)	24.0

* The 2 adolescents for whom pubertal status was uncertain were excluded from calculations of anaemia prevalence.

Adolescent and FP anthropometry

Heights and weights were measured for both adolescent and FP participants. These measures were used also to calculate a body mass index (BMI) (kg/m^2) for each participant.

Adolescent anthropometric outcomes are summarised by sex and pubertal status in **Table 12**. Mean weight and height for female adolescents were 51.3 [11.3] kg and 156.9 [7.04] cm, respectively, and 58.4 [16.1] kg and 161.1 [11.0] cm for male adolescents. Median BMI was 20.1 [5.13, 13.3-30.9] for females and 21.4 [6.86, 15.7-39.6] for males, and 21.3 [5.11, 16.6-30.9] and 21.8 [7.86, 15.7-39.6] for pubertal females and males, respectively. Median BMI was 17.3 [4.05, 13.3-23.0]) for pre-pubertal adolescents, and 21.7 [6.85, 15.7-39.6] for pubertal adolescents. Median BMI was significantly lower for pre-pubertal compared to pubertal adolescents (W = 123, p-value <0.01), though it was not significantly different between females and males (W = 432, p-value = 0.29) nor between pubertal females and males (W = 238, p-value = 0.58).

Table 12: Adolescent anthropometric outcomes by sex (n = 64) and pubertal status (n = 58)

Sex / pubertal group	n	Weight (kg)	Height (cm)	BMI (kg/m^2)
Female	32	51.3 [11.3][a]	156.9 [7.04][a]	20.1 [5.13, 13.3-30.9][b]
Male	32	58.4 [16.1][a]	161.1 [11.0][a]	21.4 [6.86, 15.7-39.6][b]
Pre-pubertal (all)	12	43.7 [10.0][a]	154.6 [10.3][a]	17.3 [4.05, 13.3-23.0][b]
Pubertal (all)	46	53.6 [19.8, 33.3-97.9][b]	160.0 [8.72][a]	21.7 [6.85, 15.7-39.6][b]
Pubertal females	22	53.5 [9.67][a]	157.2 [6.46][a]	21.3 [5.11, 16.6-30.9][b]
Pubertal males	24	62.3 [16.2][a]	164.3 [9.22][a]	21.8 [7.86, 15.7-39.6][b]

[a] Mean [sd]

[b] Median [IQR, range]

Adolescent height-for-age (HAZ) and BMI-for-age (BAZ) *z*-scores are summarised in **Table 13**. HAZ outcomes were normal (i.e. > -1 SD) for the majority of participating adolescents (75.1 %). 23.4% of adolescents had HAZ outcomes between -1 and -2 SD below the group mean, putting them at risk of stunting. One participant was found to be stunted, with a HAZ outcome between -2 and -3 SD below the group mean. HAZ outcomes are represented graphically for all adolescents in **Figure 1**, and for each females and males in **Figure 2**. In both graphs, there is a slight left-shift and flattening of the HAZ distribution for study participants compared to the reference curves.

42.0% of adolescents returned normal BAZ outcomes (i.e. -1 < x < 1 SD), while 17.2% were at risk of underweight. One participant was wasted. 26.6% of adolescent participants were at risk of overweight (i.e. 1 < x < 2 SD), 7.8% were overweight (2 < x < 3 SD) and 4.7% were obese (i.e. > 3 SD). BAZ outcomes are presented graphically for all adolescents in **Figure 3** and by sex in **Figure 4**. The distribution of BAZ outcomes for participating adolescents is bimodal and shifted to the right of the reference curve, with tails in the sample population being fatter than those in the reference distribution, particularly towards the right tail. Further, the right-shift is more prominent for the male BAZ distribution (see **Figure 4**).

Table 13: Height-for-age (HAZ) and BMI-for-age (BAZ) outcomes for all adolescents, n = 64*

z-score	**HAZ**	**BAZ**	**HAZ**	**BAZ**
	#		%	
Below -3 SD	0	0	0.0	0.0
Between -3 and -2 SD	1	1	1.6	1.6
Between -2 and -1 SD	15	11	23.4	17.2
Between -1 and 0 SD	25	14	39.1	21.9
Between 0 and 1 SD	17	13	26.6	20.3
Between 1 and 2 SD	5	17	7.8	26.6
Between 2 and 3 SD	0	5	0.0	7.8
Above 3 SD	1	3	1.6	4.7
Total	64	64	100	100

* As per WHO 2007 criteria for children aged 5-19 y

Figure 1: Adolescent height-for-age z-scores

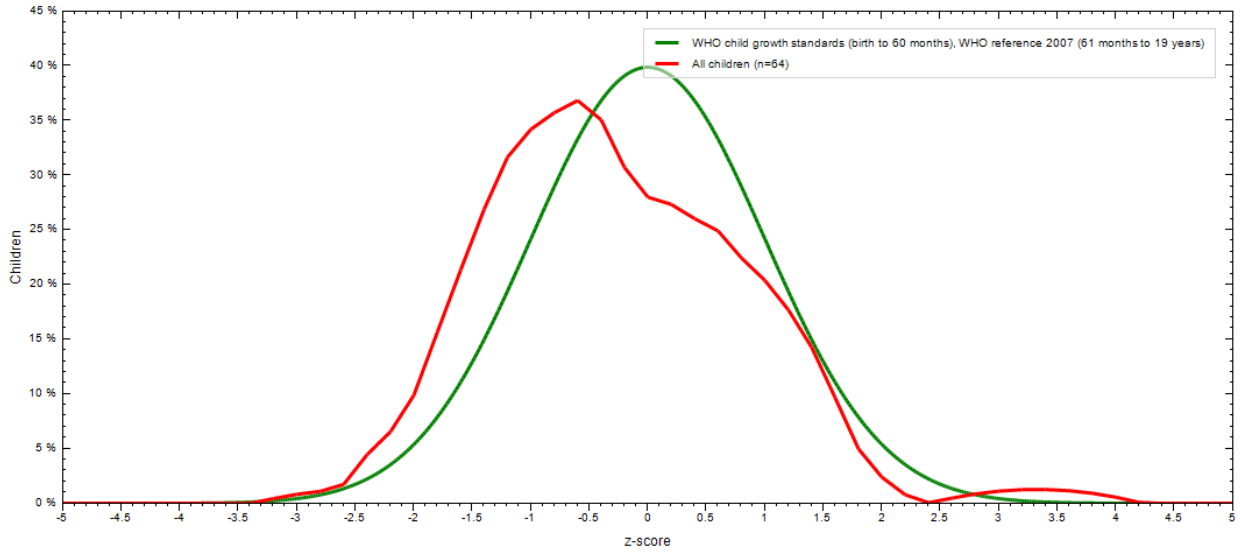


Figure 2: Adolescent height-for-age z-scores by sex

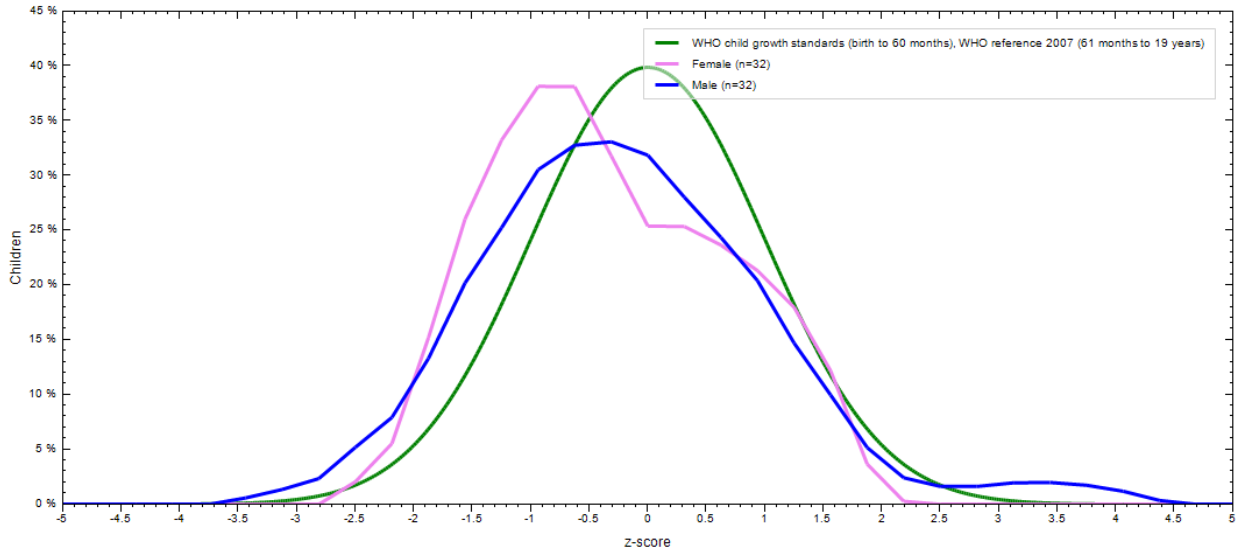


Figure 3: Adolescent BMI-for-age z-scores

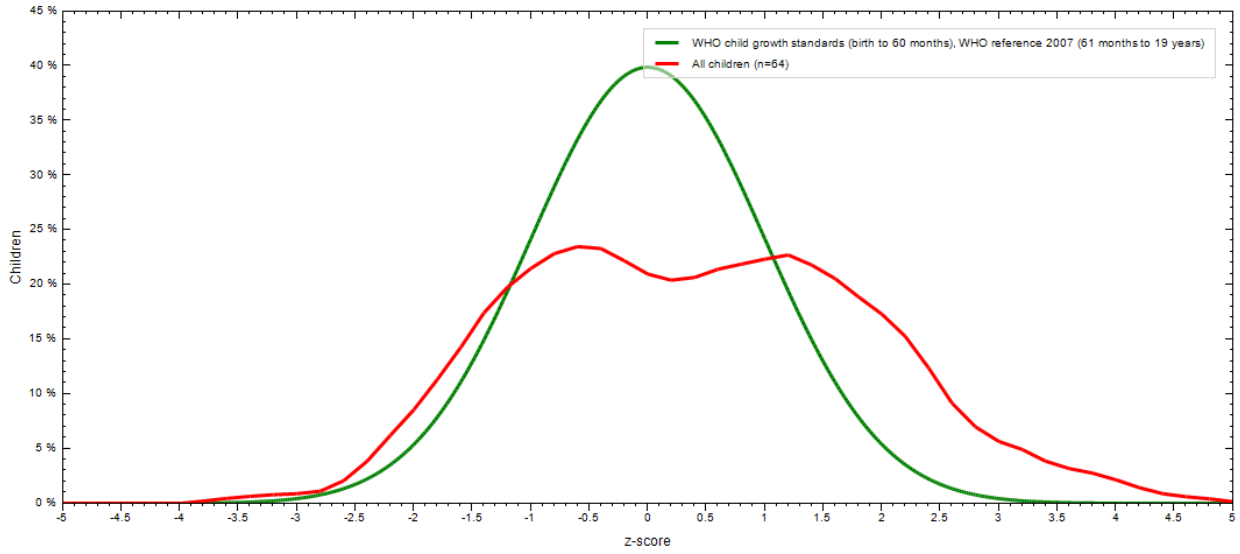
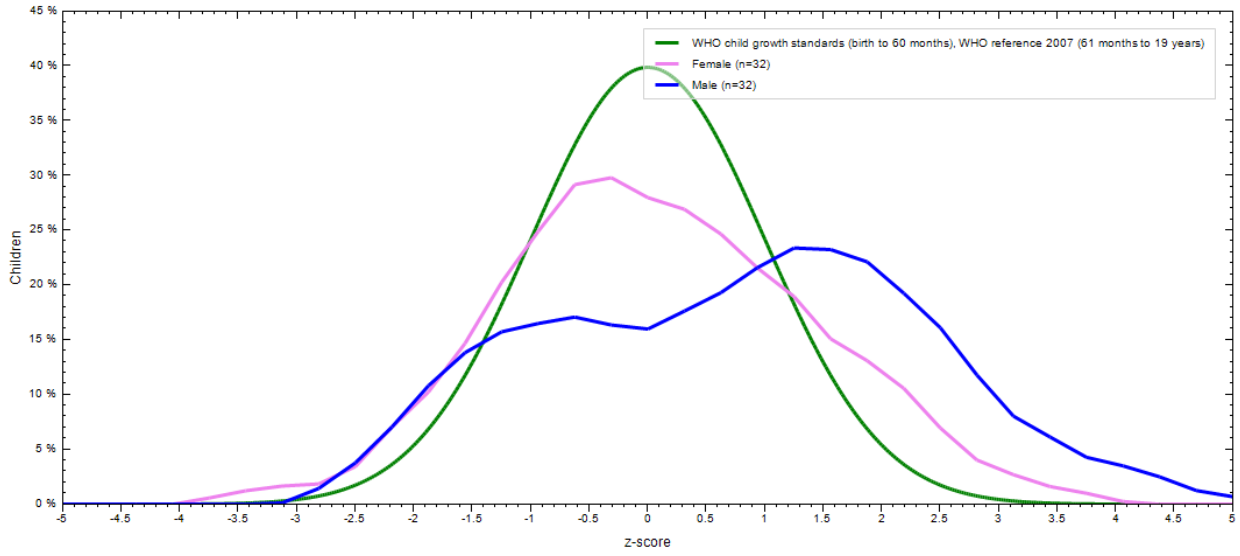


Figure 4: Adolescent BMI-for-age z-scores by sex



Adolescent HAZ and BAZ outcomes are further summarised by sex in **Table 14**. The proportions of females and males with normal BAZ outcomes were 53.1% and 31.3%, respectively. 18.8% of females and 34.4% of males had BAZ outcomes that put them at risk of overweight. The

proportion of overweight and obese males was 9.4% for each category. No female adolescents were found to be obese, although 6.3% were found to be overweight. Group comparison tests of HAZ and BAZ category proportions by sex and pubertal group were not possible given sample size limitations.

Table 14: Adolescent height-for-age (HAZ) and BMI-for-age (BAZ) outcomes by sex (n 64)

	Females				**Males**			
z-score	HAZ	BAZ	HAZ	BAZ	HAZ	BAZ	HAZ	BAZ
	#		%		#		%	
Below -3 SD	0	0	0.0	0.0	0	0	0.0	0.0
Between -3 and -2 SD	0	1	0.0	3.1	1	0	3.1	0.0
Between -2 and -1 SD	10	6	31.3	18.8	5	5	15.6	15.6
Between -1 and 0 SD	12	8	37.5	25.0	13	6	40.6	18.8
Between 0 and 1 SD	7	9	21.9	28.1	10	4	31.3	12.5
Between 1 and 2 SD	3	6	9.4	18.8	2	11	6.3	34.4
Between 2 and 3 SD	0	2	0.0	6.3	0	3	0.0	9.4
Above 3 SD	0	0	0.0	0.0	1	3	3.1	9.4
Total	32	32	100.0	100.0	32	32	100.0	100.0

FP anthropometric outcomes are summarised in **Table 15**. Mean weight, height and BMI for FP participants were 80.1 [14.9] kg, 158.7 [5.97] cm and 31.8 [5.87] kg/m^2, respectively. The majority of FPs were obese (57.1%). 28.6% of FPs were overweight, and 14.3% were of normal weight. No FPs were underweight.

Table 15: FP anthropometric outcomes, n = 63

Anthropometric outcome	**Mean [standard deviation (sd)]**
Height (cm)	158.7 [5.97]
Weight (kg)	80.1 [14.9]
BMI (kg/m^2)	31.8 [5.87]
BMI category	**%**
Underweight (<18.5 kg/m^2)	0.00
Normal weight (18.5-24.9 kg/m^2)	14.3
Overweight (25.0-29.9 kg/m^2)	28.6
Obese (BMI > 30.0 kg/m^2)	57.1

Adolescent 24-hr food recall

24-hr recall data were collected from all 66 adolescent participants. These data are summarised with respect to the 10 food groups contributing to the calculation of the DDS-M. This is presented in terms of the proportions of adolescents consuming foods from each of these groups, and in a summary of DDS-M outcomes by sex, recall group and Hb status.

Adolescent micronutrient diet diversity: DDS-M

DDS-M data are summarised in **Table 16**. DDS-M data for adolescents as a whole and adolescents in the single recall group were non-normal. Median adolescent DDS-M was 4 [1.63, 2-6]. DDS-M data within sex groups (i.e. all female and all male) and in the multiple recall groups were normally distributed. Mean DDS-M for all females and all males were 3.79 [0.87] and 4.10 [0.99], respectively. DDS-M was not significantly different between females and males (t = -1.36, df = 63.1, p-value = 0.18). DDS-M was also not significantly different across age or recall groups (χ^2= 2.63, df = 2, p-value = 0.27). As no sex differences or recall-based differences were found, these data were combined for subsequent comparisons of DDS-M in terms of Hb concentration.

Table 16: DDS-M summarised by sex and recall group

Group	n	Median [IQR, range][a] / mean [sd][b] DDS-M
All adolescents	66	4 [1.63, 2-6][a]
Females (all) 10-19 y	33	3.79 [0.87][b]
Males (all) 10-19 y	33	4.10 [0.99][b]
1 recall	31	4 [2, 2-6][a]
2 recalls	17	3.60 [0.81][b]
3 recalls	18	3.96 [0.78][b]

Adolescent DDS-M and Hb status

DDS-M was not found to be correlated with Hb concentration (rho = 0.23; S = 37110, p-value = 0.07) or BMI (rho = -0.13, S = 49238, p-value = 0.32). Median DDS-M was also compared for two sets of Hb concentration groups: [1] Hb adequate and inadequate, and [2] low and high Hb groups. Median DDS-M was not significantly different for adolescents with adequate compared to inadequate Hb concentrations (W = 547.5, p-value = 0.15), nor for low and high Hb concentration groups (W = 288.5, p-value = 0.22). DDS-M data were further divided into tertiles (T) as follows: T1 = DDS-M ≤ 3, T2 = DDS-M 3 < x ≤ 4, and T3 = DDS-M 4 < x ≤ 6. Proportions of males and females falling into each of these tertile groups were not significantly different (χ^2 = 3.68, df = 2, p-value = 0.16). Anaemia prevalence was also not found to be significantly different across these groups (χ^2 = 3.10, df = 2, p-value = 0.21).

Foods reported

The proportions of adolescents consuming foods from each of the 10 food groups used to calculate the DDS-M are summarised in **Figure 5**. Examples of foods consumed by adolescents from each DDS-M food group are given in **Table 17**. The foods consumed by the largest proportion of adolescents were those belonging to the *Grains, white roots and tubers, and plantains* group, with 100% of adolescent participants reporting consumption of these foods. The *Milk and milk products* food group and the *Other fruits* food group were the groups consumed by the second and third largest proportions of adolescents, respectively. 84.8% of adolescents reported consuming from the *Milk and milk products* food group, and 59.1% reported consuming from the *Other fruits* food group. Foods belonging to the *Other vitamin A-rich fruits and vegetables*

and *Nuts and seeds* food groups were consumed by the smallest proportions of adolescents (4.5% and 9.1%, respectively).

Figure 5: Proportion of adolescents (%) consuming from each of the 10 food groups used in the calculation of the DDS-M, n = 66

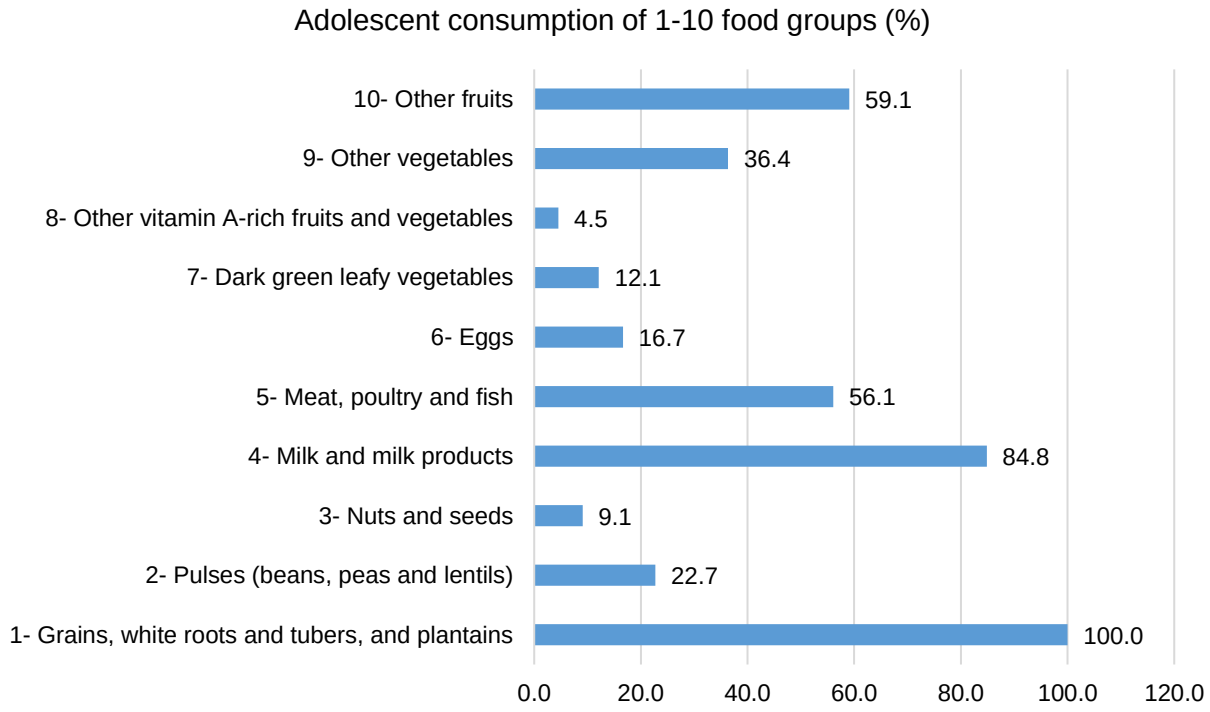


Table 17: Examples of foods reported by adolescent participants in recalls alongside associated DDS-M food groups

Food group	Examples of foods reported (Arabic name - Transliterated name - English name)
Grains, white roots and tubers, and plantains	مناقيش - Manāʾīsh - Levantine pizza كعك - Kaʿk - Savoury sesame bread
Pulses (beans, peas and lentils)	شوربة عدس - Shūrabat ʿadas - Lentil soup حمّص مطحون - Ḥimmaṣ maṭḥūn - Chickpea dip
Nuts and seeds	بذر مصريّ - Bidhr maṣriyy - 'Egyptian' Melon seeds طحينة - Taḥīna - Tahini
Milk and milk products	لبنة - Labna - Strained yoghurt خيار بلبن - Khiyar b'laban - Yoghurt cucumber side
Meat, poultry and fish	سمك مشويّ - Samak mishwiyy - Fish (BBQ) ورق عنب (لحم) - Waraq ʿinab (laḥm) - Stuffed grape leaves with stewed meat
Eggs	بيض مقليّ - Bayd maqliyy - Fried egg عجّة - ʿujja - Omelette
Dark green leafy vegetables	سبانخ و رز - Sabānikh w'ruz - Spinach and rice ملوخية ناعمة - Mulūkhiya naʿma - Jute mallow soup
Other vitamin A-rich fruits and vegetables	منقوشة حرّ - Manʾoushat ḥarr - Chilli paste pizza سلطة جزر - Salaṭat jazar - Carrot salad
Other vegetables	لوبيا بزيت - Lūbyā b'zayt - Green beans بامية و رز – Bāmiya w'ruz - Okra and rice
Other fruits	تفّاح - Tuffāḥ - Apple درّاء - Durrāʾ - Peach

Hb concentration was further compared based on consumption or not of food groups ascribed as high-iron source foods: [1] the *Meat, poultry and fish* food group and [2] a combined plant source food group: *Pulses (beans, peas and lentils)*, *Nuts and seeds* and *Dark green leafy vegetables*. The plant source food group was considered consumed from if an adolescent had reported intake from at least one of the three food groups assigned to it. Mean Hb concentration was not significantly different for adolescents consuming from the *Meat, poultry and fish*, compared to those who did not (t = 1.78, df = 57.8, p-value = 0.08). There was also no significant difference in Hb concentration for adolescents consuming from either of the *Pulses (beans, peas and lentils)*, *Nuts and seeds* and *Dark green leafy vegetables* food groups and not (127 [12.2] and 128 [13.8] g/L; t = -0.11, df = 55.8, p-value = 0.91).

Household plant source food preparation

56 FPs contributed data on plant source food use in their households. 58 different meals were reported in total. These meals are listed in **Table 18** in descending order of the proportions of FPs reporting preparation of each meal in their households (%).

Table 18: All plant source foods reported by FPs

Reported plant source food – Arabic name	Reported plant source food – Transliterated name	Plant source food main ingredient – English name	% of FPs (n = 56) reporting preparation of meal in household
هندباء (علت)	Hindbāʾ (ʿilit)	Chicory	75.0[a]
ملوخية ناعمة	Mulūkhiya nāʿma	Jute mallow	62.5[a]
خبّيزة	Khubbayza	Mallow	48.2[a]
لوبيا بزيت	Lūbyā b'zayt	Green beans	46.4[a]
سبانخ و رز	Sabānikh w'ruz	Spinach	46.4[a]
ملوخية ورق	Mulūkhiya waraq	Jute mallow	42.9[a]
سلطة زعتر أخضر	Salaṭat zaʿtar akhḍar	Wild thyme	42.9[a]
تبّولة	Tabbūla	Parsley	41.1[a]
فاصوليا و رز بشعيرية	Fāṣūliyā w'ruz b'shiʿiriyya	White kidney beans	39.3[a]
فطائر بالسبانخ	Faṭāiʾr b'ssabānikh	Spinach	35.7[a]
سلطة بقلة (فرفحينة)	Salaṭat baqla (farfahīna)	Purslane	33.9[a]
شوربة عدس	Shūrabat ʿadas	Lentils	30.4[a]
كوسا محشية	Kūsā mihshiyya	Zucchini	26.8[a]
مقلوبة بازلاء (بازلاء و رز)	Maqlūbat bāzillāʾ (bāzillāʾ w'ruz)	Green peas	23.2[a]
فطائر بزعتر أخضر	Faṭāiʾr b'zaʿtar akhḍar	Wild thyme	21.4[a]
مجدّرة برز	Mujaddara b'ruz	Lentils	19.6[a]

Reported plant source food – Arabic name	Reported plant source food – Transliterated name	Plant source food main ingredient – English name	% of FPs (n = 56) reporting preparation of meal in household
مجدّرة ببرغل	Mujaddara b'burghul	Lentils	19.6[a]
سلق محشي (لحم)	Siliq mihshiyy (lahm)	Silverbeet	17.9
شوربة سلق و عدس	Shūrabat siliq w'ᶜadas	Silverbeet, lentils	17.9
فتّوش	Fattūsh	Parsley, lettuce	16.1
بامية و رز	Bāmiya w'ruz	Okra	14.3
أربوزة (قطيفة)	Aᵓrbūza (Qiṭṭayfa)	Amaranth	14.3
لوبيا ببندورة	Lūbyā b'banadūra	Green beans	14.3
عجّة	ᶜujja	Parsley, mint	12.5
شمر و عدس	Shumar w' ᶜadas	Fennel, lentils	10.7
قرنبيط مقليّ	Qarnabīṭ maqliyy	Cauliflower	10.7
حمّص مطحون	Ḥimmaṣ maṭḥūn	Chickpeas	10.7
عكّوب	ᶜAkkūb	Gundelia	8.9
ورق عنب بلحمة	Waraq ᶜinib b'laḥma	Grape leaves	7.1
صلصة بقلة	Ṣalṣat baqla	Purslane	7.1
سلطة روكا (جرجير)	Salatat rūkkā (jarjīr)	Rocket	7.1
مقلوبة قرنبيط	Maqlūbat qarnabīt	Cauliflower	7.1
سلق محشي (خضار)	Siliq mihshī	Silverbeet	5.4
فول	Fūl	Fava beans	5.4
باذنجان محشي	Bāthinjān mihshī	Eggplant	5.4
ملفوف	Malfūf	Cabbage	5.4
متبّل باذنجان	Mutabbal bāthinjān	Eggplant	5.4
لوبيا بلحمة	Lūbyā b'laḥma	Green beans	3.6
ورق عنب بخضار	Waraq ᶜinib b'khuḍār	Grape leaves	3.6
فطائر بحمّيضة	Faṭāᵓir b'ḥimmayḍa	Dock	3.6
فتّة (تسئية)	Fatta (tisᵓiyya)	Chickpeas	3.6
لوبيا و رز	Lūbyā w'ruz	Green beans	3.6
قرنبيط بطحينة	Qarnabīṭ b'ṭaḥīna	Cauliflower	3.6
حمّيضة نيّة	Ḥimmayḍa nayya	Wood sorrel	3.6
طاجن	Ṭājin	Eggplant	3.6
سلق بلوبيا	Siliq b'lūbyā	Silverbeet, black-eyed beans	1.8
بقلة و لبن	Baqla w'laban	Purslane	1.8
باذنجان مشوي	Bāthinjān mishwiyy	Eggplant	1.8
مُسَبَّحة	Musabbaḥa	Chickpeas	1.8
حبايب	Ḥabāyib	Chickpeas, wheat grains	1.8
قرصعنّة	Qursᵊanna	Eryngo	1.8
بطاطا بكزبرة	Baṭāṭā b'kuzbara	Potato, coriander	1.8
يخنة بطاطا	Yakhnat baṭāṭā	Potato	1.8

Reported plant source food – Arabic name	Reported plant source food – Transliterated name	Plant source food main ingredient – English name	% of FPs (n = 56) reporting preparation of meal in household
بصارَة	Biṣāra	Fava beans, jute mallow	1.8
برغل ببندورة	Burghul b'banadūra	Crushed wheat, tomato	1.8
خبّيزة و شمر	Khubbayza w'shumar	Mallow, fennel	1.8
فلافل	Falāfil	Fava beans, chickpeas	1.8
فطائر ببقلة	Faṭāᵓir b'baqla	Purslane	1.8

[a] Meals for which subsequent descriptions were made

Plant-based meals from this list were described further where at least 20% of FPs reported the meal's preparation in their households (marked '[a]' in **Table 18**). Literature reports of non-haem iron contents for each of these meals were then assessed to determine likely amounts therein (see **Table 19**). Of these meals, those that likely contained ≥ 1mg of non-haem iron per 100g were then described further (see **Table 20**).

Table 19: Candidate plant source foods with associated non-haem iron content (mg/100g)

Reported plant source food – Arabic name	Reported plant source food – Transliterated name	Plant source food main ingredient – English name	Non-haem iron content of main ingredient[a] or meal[b] (where available) [mg/100g]
هندباء (علت)	Hindbāᵓ (ᶜilit)	Chicory	2.8[a] (Simaan et al., 1964) 1.9[b] (Hoteit et al., 2020)
ملوخية ناعمة	Mulūkhiya nāᶜma	Jute mallow	9.6[a] (Simaan et al., 1964) 1.2[b] (Hoteit et al., 2020)
خبّيزة	Khubbayza	Mallow	12.8[a] (Batal & Hunter, 2007)
لوبيا بزيت	Lūbyā b'zayt	Green beans	3.4[a] (Simaan et al., 1964) 1.1[b] (Hoteit et al., 2020)
سبانخ و رز	Sabānikh w'ruz	Spinach	2.8[a] (Simaan et al., 1964)
ملوخية ورق	Mulūkhiya waraq	Jute mallow	9.6[a] (Simaan et al., 1964) 1.2[b] (Hoteit et al., 2020)

Reported plant source food – Arabic name	Reported plant source food – Transliterated name	Plant source food main ingredient – English name	Non-haem iron content of main ingredient[a] or meal[b] (where available) [mg/100g]
سلطة زعتر أخضر	Salaṭat zaᶜtar akhḍar	Wild thyme	0.19 [a] (Batal & Hunter, 2007)
تبّولة	Tabbūla	Parsley	5.5[b] (J. W. Cowan et al., 1967) 1.4[b] (Hoteit et al., 2020)
فاصوليا و رز بشعيرية	Fāṣūliyā w'ruz b'shiᶜiriyya	White kidney beans	9.4[a] (Kuzayli et al., 1966) 1.2[b] (Hoteit et al., 2020)
فطائر بالسبانخ	Faṭāiᵓr b'ssabānikh	Spinach	2.8[a] (Simaan et al., 1964)
سلطة بقلة (فرفحينة)	Salaṭat baqla (farfahīna)	Purslane	1.8[a] (Simaan et al., 1964)
شوربة عدس	Shūrabat ᶜadas	Lentils	7.8[a] (Kuzayli et al., 1966)
كوسا محشية	Kūsā mihshiyya	Zucchini	1.4[b] (Hoteit et al., 2020)
مقلوبة بازلاء (بازلاء و رز)	Maqlūbat bāzillāᵓ (bāzillāᵓ w'ruz)	Green peas	1.8[a] (Simaan et al., 1964)
فطائر بزعتر أخضر	Faṭāiᵓr b'zaᶜtar akhḍar	Wild thyme	0.19[a] (Batal & Hunter, 2007)
مجدّرة برز	Mujaddara b'ruz	Lentils	6.2[b] (J. W. Cowan et al., 1967) 1.3[b] (Hoteit et al., 2020)
مجدّرة ببرغل	Mujaddara b'burghul	Lentils	7.8[a] (Kuzayli et al., 1966)

Both meals that utilised wild thyme as a main ingredient were excluded from further description, as the iron content of wild thyme was < 1mg per 100g (Batal & Hunter, 2007). The zucchini meal was also excluded, as the meal analysed included meat and, as the iron content of zucchini is less than < 1mg per 100g on its own (Food Standards Australia and New Zealand [FSANZ], 2021), the value given for iron here was interpreted to be a reflection of haem rather than non-haem iron content. The final number of reported plant source foods used in subsequent meal descriptions

was 14. These meals are described with reference to main ingredients, aggregated meal preparation approaches and usual consumption details in **Table 20**.

Table 20: Commonly reported plant-based meals with non-haem iron contents ≥ 1mg/100g

Plant-based meal	Meal description	Meal ingredients	Meal preparation	Consumption details
Hindbāʾ (ʿilit)	Dish of boiled and sautéed chicory.	Chicory Onion Oil (corn, sunflower or olive)	1. Chicory boiled in water (sometimes also with sodium bicarbonate), strained and wrung out by hand. 2. Onion sautéed in oil. 3. Boiled chicory added to onion and sautéed briefly.	Lemon juice often added to meal at serving Meal eaten with flatbread Plain yoghurt sometimes had along with meal Lentil soup sometimes had along with meal
Mulūkhiya nāʿma	Dish of finely chopped jute mallow soup, often including meat or meat substitute (i.e. meat-flavoured stock cube).	Jute mallow (fresh or dried) Meat or stock cube Coriander Garlic Oil (corn, sunflower or olive)	1. Sauté garlic and coriander in oil. 2. Add stock and water to create broth. 3. Add jute mallow and boil briefly.	Lemon juice often added to meal at serving Meal eaten either with vermicelli rice or flatbread
Khubbayza	Dish of sautéed mallow.	Mallow Onion Oil (corn, sunflower or olive)	1. Sauté onion in oil. 2. Add mallow and sauté briefly.	Lemon juice often added to meal at serving Meal eaten with flatbread
Lūbyā b'zayt	Dish of stewed green beans.	Green beans Onion Oil (corn, sunflower or olive)	1. Sauté onion in oil. 2. Add beans, stock, a small amount of water, and stew.	Salad of tomato, cucumber, lemon juice and oil often had along with meal

Plant-based meal	Meal description	Meal ingredients	Meal preparation	Consumption details
		*Stock cube sometimes added		Side dish of yoghurt, chopped cucumber, garlic and mint alternatively had along with meal Meal eaten with flatbread
Sabānikh w'ruz	Dish of spinach with minced beef/lamb or meat substitute (i.e. meat-flavoured stock cube).	Spinach Beef/lamb mince or stock cube Garlic Oil (corn, sunflower or olive)	1. Sauté meat in oil. 2. Add spinach and garlic and sauté further. 3. Add water and stew.	Lemon juice often added to meal at serving Meal eaten with vermicelli rice
Mulūkhiya waraq	Dish of stewed jute mallow.	Jute mallow (fresh or dried) Meat / stock cube Coriander Garlic Oil (corn, sunflower or olive) or clarified butter	1. Sauté meat, garlic and coriander in oil or clarified butter. 2. Add jute mallow leaves and sauté further.	Lemon juice often added to meal at serving Meal eaten with flatbread
Tabbūla	Salad of finely chopped parsley, onion, mint, tomato and sprinkle of crushed wheat, dressed with lemon juice and oil.	Parsley Mint (fresh or dried) Onion (raw green or white, or dried) Lemon juice or lemon salt Oil (corn, sunflower or olive) Crushed wheat (fine)	1. Chop ingredients finely and dress. 2. Crushed wheat either soaked in a small amount of water or lemon juice ahead of use, or sprinkled dry over salad.	Mostly eaten as accompaniment to other dishes (e.g. fried fish, fried potato or grilled meat)
Fāṣūliyā w'ruz b'shi^{c}iriyya	Kidney bean tomato stew, often including beef.	White kidney beans (dried) Beef Onion	1. Dried beans soaked in water (sometimes also with sodium bicarbonate) overnight.	Meal eaten with vermicelli rice

Plant-based meal	Meal description	Meal ingredients	Meal preparation	Consumption details
		Tomato (fresh, canned, juice or paste) Oil (corn, sunflower or olive) Coriander Garlic	2. Beans strained then boiled until soft. Water decanted. 3. Sauté onion and meat in oil. 4. Add beans, tomato and water and boil. 5. Sauté garlic and coriander in oil and add.	
Faṭāiᵒr b'ssabānikh	Spinach-filled pastries.	Flour dough Spinach Onion Oil (corn, sunflower or olive) Chilli (powdered) *Sumac sometimes included in filling	1. Chop spinach and onion. 2. Bring filling together with chilli and oil. 3. Stuff dough to make individual pastries. 4. Bake dry or with oil.	Sometimes eaten with dip of plain yoghurt.
Salaṭat baqla (farfahīna)	Purslane salad.	Purslane Onion (raw white or dried) Lemon juice / lemon salt Chilli (powdered) Oil (corn, sunflower or olive)	1. Chop purslane and onion and dress with lemon juice / lemon salt and oil.	Mostly eaten as accompaniment to other dishes (e.g. fried fish, fried potato or grilled meat)
Shūrabat ᶜadas	Lentil soup.	Lentils (dried) Onion Oil (corn, sunflower or olive)	1. Sauté onion in oil. 2. Add lentils and water, and boil until soft.	Lemon juice often added to meal at serving
Maqlūbat bāzillāᵒ (bāzillāᵒ w'ruz)	Green pea and tomato stew, often including meat or meat substitute (i.e.	Green peas Meat or stock cube Garlic Coriander	1. Boil meat if using, then sauté with garlic, peas and coriander.	Meal eaten with vermicelli rice

Plant-based meal	Meal description	Meal ingredients	Meal preparation	Consumption details
	meat-flavoured stock cube).	Tomato (fresh, canned, juice or paste)	2. Add tomato and meat broth and boil.	
Mujaddara b'ruz	Lentil and rice pilaf.	Lentils (dried) Rice Onion Oil (corn, sunflower or olive)	1. Boil lentils in water. 2. Add rice and stew. 3. Sauté or fry onion in oil and add to top of pilaf.	Plain yoghurt and / or salad of tomato, cucumber, lemon juice and oil had along with meal
Mujaddara b'burghul	Crushed wheat and lentil pilaf.	Lentils (dried) Crushed wheat Onion Oil (corn, sunflower or olive)	1. Boil lentils in water. 2. Add crushed wheat and stew. 3. Sauté or fry onion in oil and add to top of pilaf.	Plain yoghurt and / or salad of tomato, cucumber, lemon juice and oil had along with meal

Ingredients and consumption elements are also further presented with reference to likely non-haem iron absorption enhancement or inhibition status in **Table 22**, as are food preparation elements that may impact non-haem iron bioavailability. Descriptions are made with reference to ingredients or food preparation techniques that have the capacity to influence non-haem iron bioavailability. The food components described and their enhancer and inhibitor statuses are outlined in **Table 21** for reference.

Table 21: Non-haem iron absorption enhancer and inhibitor status of food components

Food component	Enhancer / inhibitor status
Phytic acid	*Inhibitor* Amounts as small as 2mg of phytic acid have been shown to exert a significant inhibitory effect on non-haem iron absorption (Teucher et al., 2004; Zijp et al., 2000).
Ascorbic acid	*Enhancer* ≥ 30mg of ascorbic acid has been shown to overcome phytic acid inhibition of non-haem iron absorption, as has ≥ 50mg of ascorbic acid given polyphenol inhibition (Siegenberg et al., 1991).
Muscle tissue	*Enhancer* ≥ 50g of muscle tissue has been shown to overcome phytic acid inhibition of non-haem iron absorption (Baech et al., 2003). No specific data that estimate the particular impact of muscle tissue overcoming on polyphenol inhibition are available. This minimum is proposed based on the general enhancing contribution of 27-30g of meat protein in mixed test dishes with low ascorbic acid content (Monsen et al., 1978; Tseng et al., 1997).

Table 22: Reported plant-based meals described by food preparation method contributors to non-haem iron enhancement or inhibition

Plant-based meal	Enhancing preparation or consumption method(s) reported	Inhibiting preparation or consumption method(s) reported
Hindbāᵓ (ᶜilit)	Addition of lemon juice at serving: ascorbic acid addition Consumption of fresh chilli, capsicum, radish along with meal: ascorbic acid addition	Meal consumption with flatbread: phytic acid addition
Mulūkhiya nāᶜma	Inclusion of meat in meal: muscle tissue addition	Meal consumption with flatbread or vermicelli rice: phytic acid addition

Plant-based meal	Enhancing preparation or consumption method(s) reported	Inhibiting preparation or consumption method(s) reported
	Addition of lemon juice at serving: ascorbic acid addition	Boiling of jute mallow in water for > 15 mins: ascorbic acid destruction
Khubbayza	Addition of lemon juice at serving: ascorbic acid addition Brief sauté of mallow: ascorbic acid destruction minimised	Meal consumption with flatbread: phytic acid addition
Lūbyā b'zayt	Addition of lemon juice at serving: ascorbic acid addition Consumption of salad of tomato, cucumber, lemon juice and oil along with meal: ascorbic acid addition	Meal consumption with flatbread: phytic acid addition Stewing of green beans in water for > 10 mins: ascorbic acid destruction
Sabānikh w’ruz	Inclusion of meat in meal: muscle tissue addition Addition of lemon juice at serving: ascorbic acid addition	Meal consumption with vermicelli rice: phytic acid addition
Mulūkhiya waraq	Inclusion of meat in meal: muscle tissue addition Addition of lemon juice at serving: ascorbic acid addition Brief sauté of jute mallow: ascorbic acid destruction minimised	Meal consumption with flatbread or vermicelli rice: phytic acid addition
Tabbūla	No heat processing Inclusion of tomato, green onion and lemon juice: ascorbic acid addition	None

Plant-based meal	Enhancing preparation or consumption method(s) reported	Inhibiting preparation or consumption method(s) reported
Fāṣūliyā w'ruz b'shiᶜiriyya	Overnight soak of dried white kidney beans in water alone or with sodium bicarbonate, and decant ahead of further use: phytic acid reduction Pre-boil of beans and decant ahead of incorporation with other ingredients: phytic acid reduction Inclusion of meat in meal: muscle tissue addition	Meal consumption with vermicelli rice: phytic acid addition Boiling of tomato component in water for > 15 mins: ascorbic acid destruction
Faṭāiʾr b'ssabānikh	Inclusion of lemon juice in filling: ascorbic acid addition	Flour dough: phytic acid addition
Salaṭat baqla (farfahīna)	No heat processing Inclusion of lemon juice: ascorbic acid addition	None
Shūrabat ᶜadas	Pre-soak of lentils and decant: phytic acid reduction Pre-boil of lentils and decant: phytic acid reduction Addition of lemon juice at serving: ascorbic acid addition	No pre-soak or -boil of lentils ahead of incorporation into meal: phytic acid addition
Maqlūbat bāzillāʾ (bāzillāʾ w'ruz)	Inclusion of meat in meal: muscle tissue addition	Boiling of tomato component in water for > 15 mins: ascorbic acid destruction Meal consumption with vermicelli rice: phytic acid addition

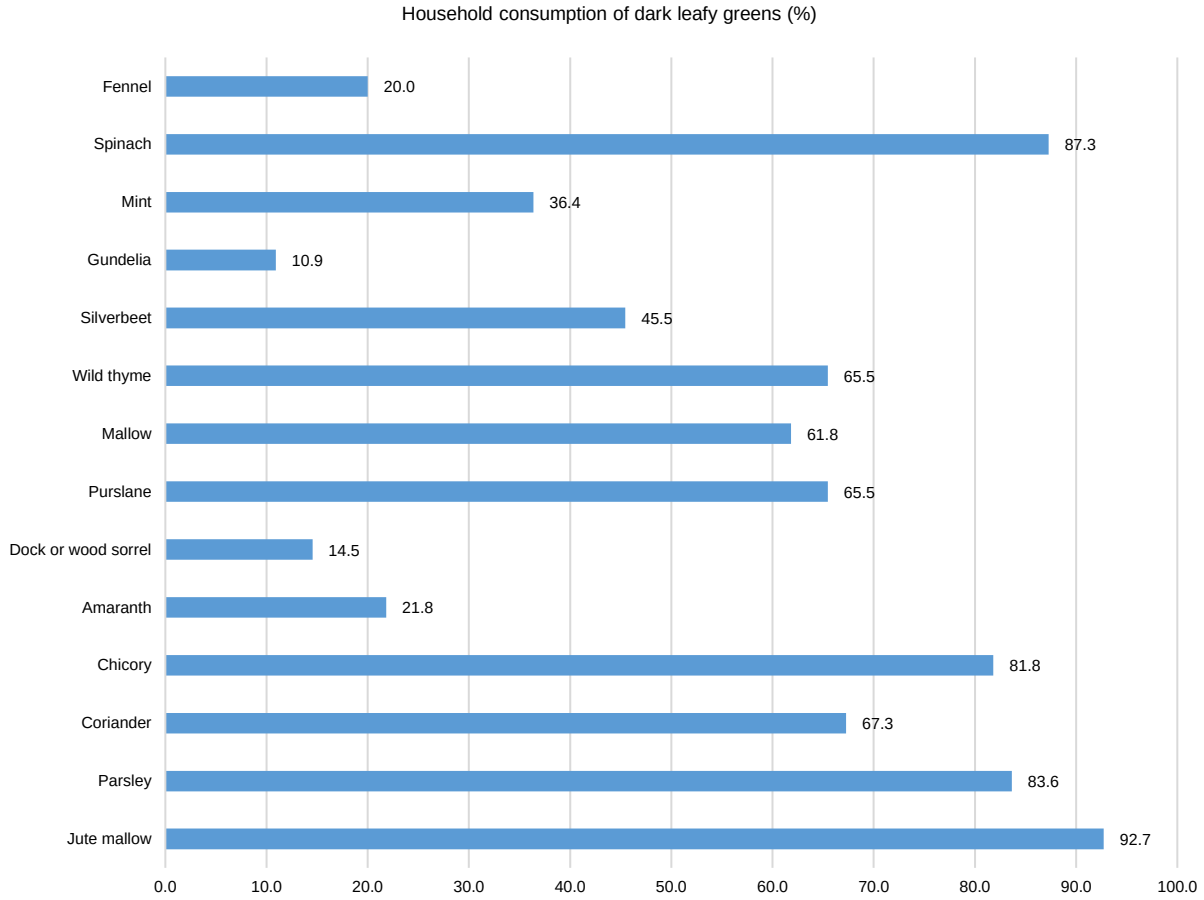
Plant-based meal	Enhancing preparation or consumption method(s) reported	Inhibiting preparation or consumption method(s) reported
Mujaddara b'ruz	Pre-soak of lentils and/or rice and decant: phytic acid reduction Pre-boil of lentils and decant: phytic acid reduction Consumption of salad of tomato, cucumber, lemon juice and oil along with meal: ascorbic acid addition	No pre-soak or -boil of lentils or rice ahead of incorporation into meal: phytic acid addition
Mujaddara b'burghul	Pre-soak of lentils and/or crushed wheat and decant: phytic acid reduction Pre-boil of lentils and decant: phytic acid reduction Consumption of salad of tomato, cucumber, lemon juice and oil along with meal: ascorbic acid addition	No pre-soak or -boil of lentils or crushed wheat ahead of incorporation into meal: phytic acid addition

Household dark leafy green use

Household use of dark leafy greens, as determined through administration of an FFQ is summarised in **Figure 6**. 55 FPs completed the dark leafy green FFQ. A dark leafy green was considered in use in the household as per this FFQ if it was in use at least once a month when in season. The dark leafy green in most frequent use in participating households was jute mallow (92.7%). Spinach and parsley were the dark leafy greens used next-most frequently, respectively (87.3% and 83.6%). The dark leafy green reported to be in use least frequently was gundelia (10.9%). Over half of all FFQ respondents reported use of 8 dark leafy greens of the total 14 included (61.8-92.7%). In ascending order of proportions of households reporting their use, these

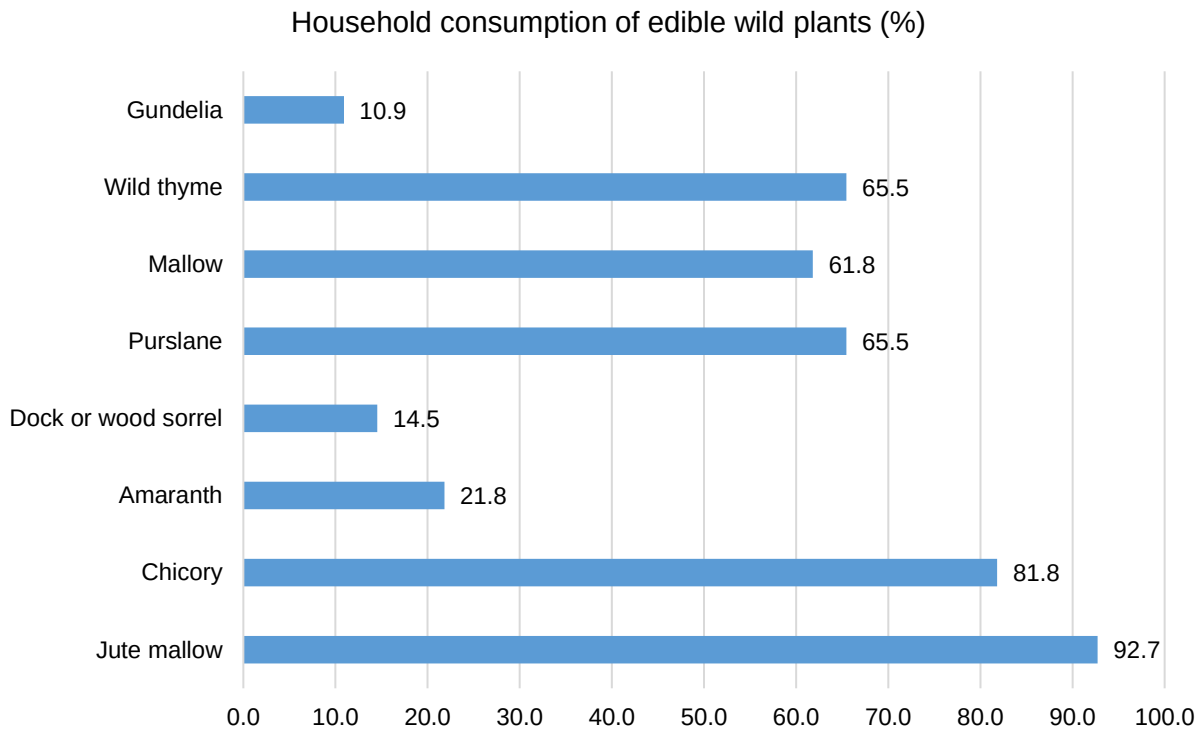
8 dark leafy greens were: mallow, wild thyme and purslane (both 65.5%), coriander, chicory, parsley, spinach and jute mallow.

Figure 6: Proportion of households (%) reporting use of each of 14 dark leafy greens, n = 55



Edible wild plants included in this FFQ were: gundelia, wild thyme, mallow, purslane, dock or wood sorrel, amaranth, chicory and jute mallow. Household use of these 8 edible wild plants is summarised in **Figure 7**. Of the 8 dark leafy greens most frequently reported to be in use, 5 were edible wild plants. In ascending order of proportions of households reporting their use, these 5 edible wild plants were: mallow, wild thyme and purslane (both 65.5%), chicory and jute mallow.

Figure 7: Proportion of households (%) reporting use of each of 8 edible wild plants, n = 55



Household dark leafy green and edible wild plant use were also examined against adolescent Hb concentration and adolescent DDS-M outcomes. Household dark leafy green and edible wild plant use, here, were described as the percentage of each used out of a possible 14 or 8, respectively. Neither dark leafy green nor edible wild plant use was correlated either with adolescent Hb concentration ($r = 0.13$, $t = 0.87$, $df = 48$, p-value = 0.39; rho = 0.20, S = 16642, p-value = 0.16) or adolescent DDS-M (rho = 0.18, S = 17048, p-value = 0.21; rho = 0.22, S = 16288, p-value = 0.1285).

These analyses were repeated for subsets of dark leafy greens and edible wild plants. These subsets were produced by locating crossover between dark leafy greens and edible wild plants also reported independently of this FFQ in the open-recall food preparation interview section preceding the dark leafy green FFQ section. Dark leafy greens and edible wild plants that were reported in food preparation interviews as being prepared in at least 20% of participating camp households (see entries marked 'a' in **Table 18** above) made up these subsets of 7 dark leafy greens (see **Figure 8**) and 5 edible wild plants (see **Figure 9**). Again, the percentage of utilised dark leafy greens of 7 and edible wild plants of 5 were examined against adolescent Hb concentration and adolescent DDS-M outcomes. Household use of these subsets of dark leafy

greens and edible wild plants was not found to be correlated with adolescent Hb concentration (rho = 0.25, S = 15594, p-value = 0.08, rho = 0.23, S = 16027, p-value = 0.11). However, while household use of the subset of edible wild plants was also not found to be correlated with adolescent DDS-M (rho = rho = 0.24, S = 15872, p-value = 0.10), use of the dark leafy green subset was found to be positively correlated with adolescent DDS-M (rho = 0.31, S = 14303, p-value = 0.03).

Figure 8: Proportion of households (%) reporting use of commonly used dark leafy greens, n = 55

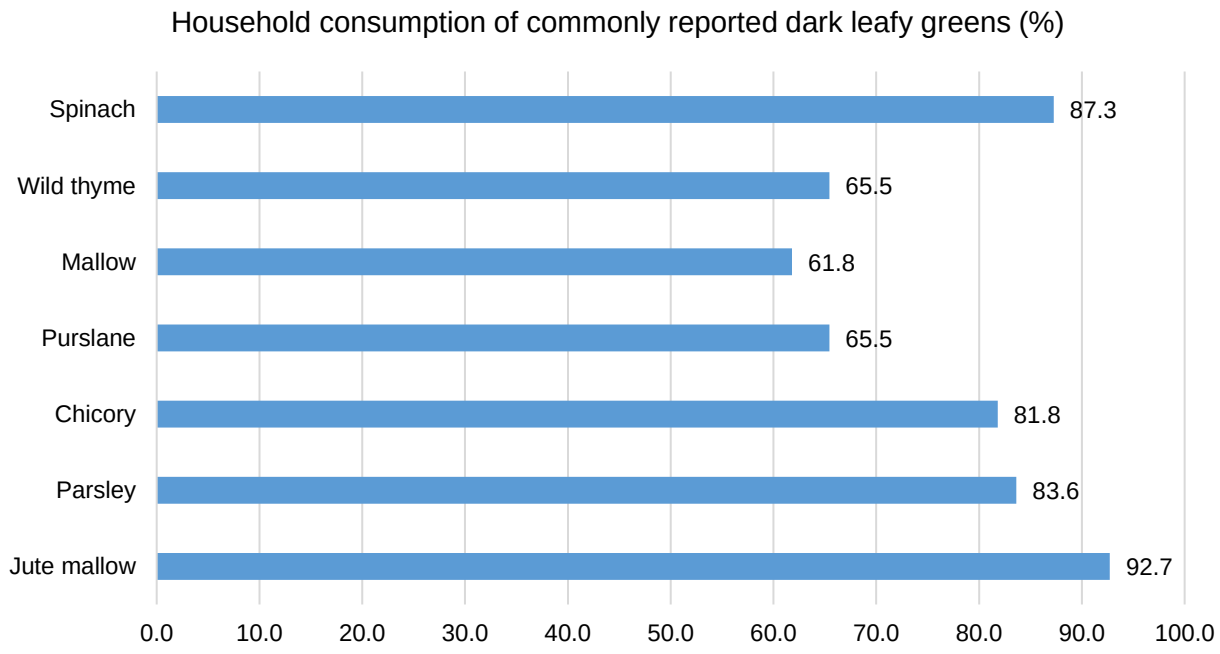
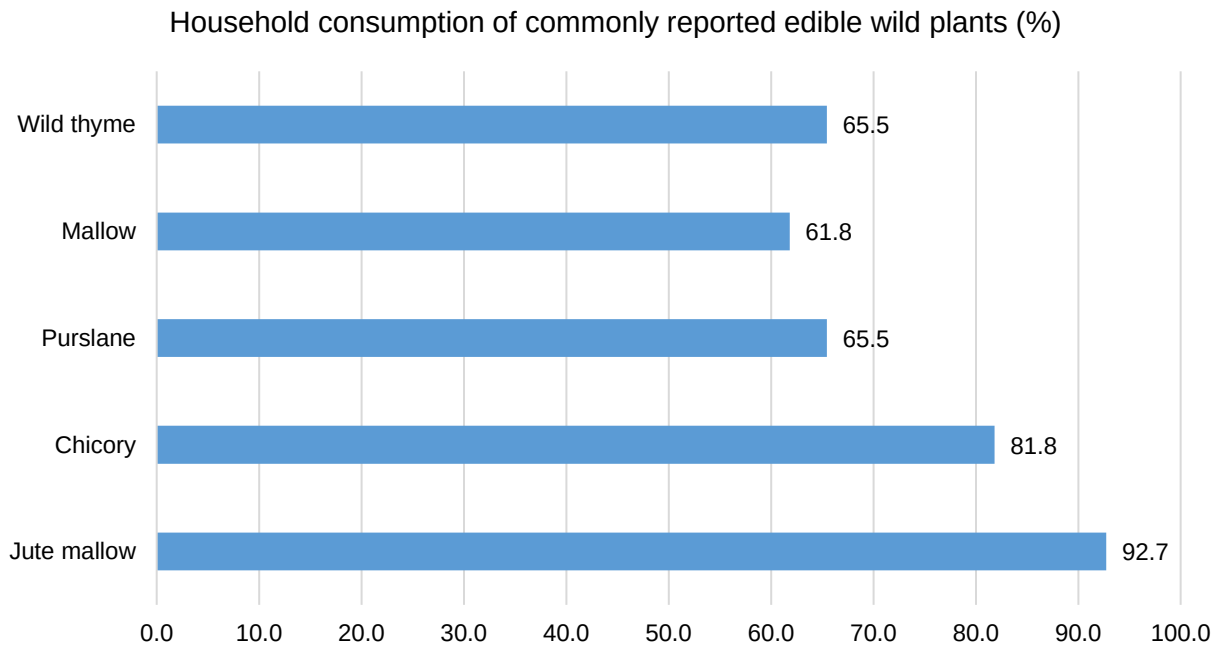


Figure 9: Proportion of households (%) reporting use of commonly used edible wild plants, n = 55



CHAPTER SIX: QUALITATIVE METHODS

The qualitative methods used in this research are outlined in this chapter. The qualitative analysis undertaken in this study was guided by a 'positive deviance' approach, and the analysis technique applied was 'reflexive thematic analysis'. Positive deviance, as an approach, and its suitability for this work, is described first in this chapter. This is followed by a detailed explanation of the reflexive thematic analysis process as applied to this project.

Positive deviance

Background

Positive deviance methodology is a type of assets-based approach to community development; it seeks to harness the successful strategies of certain members of a disadvantaged community who sustainably overcome barriers that a majority of others do not given the same conditions of disadvantage (LeMahieu et al., 2017). The general steps involved in using this approach are: [1] identifying better-performing (along a specified dimension) members of a community in the context of widespread, long-term disadvantage; [2] exploring the practices that impact on the specified dimension that are unique to these better-performing community members; and [3] disseminating these findings within the community (LeMahieu et al., 2017; Wishik & Van Der Vynckt, 1976). The goal of this approach is to harness resources and strategies already available within the community that produce better outcomes (e.g. for health) given the same difficulties, in an effort to improve outcomes though the material situation may remain unchanged (Wishik & Van Der Vynckt, 1976).

Positive deviance and community nutrition

Applied to nutritional sciences, the methodology is used to identify and harness community practices that lead to better nutritionally-impacted health outcomes than are usual in that community in a context of widespread deprivation (Wishik & Van Der Vynckt, 1976; Zeitlin, 1991). The methodology has been used in low-income areas where malnutrition and associated growth deficits are widespread, for example, to make quick assessments of locally-employable practices that improve maternal health and child development (Ahrari et al., 2006; Pryer et al., 2004). Positive deviance methodology has also been used to guide large-scale nutrition intervention programs that have produced both immediate and long-term changes to maternal and household attitudes and practices that have led to improved growth for children in those households (Mackintosh et al., 2002). Mothers and children who participated in a positive deviance-informed intervention across a handful of low-income communities in Vietnam, for example, were followed-

up with a few years after initial intervention to assess the lasting impacts of the positive deviance approach on altering food-related practices to support improved child growth (Mackintosh et al., 2002). The authors found that, not only had attitudes, practices and growth changes been sustained for a majority of households, but that younger siblings of participating children also benefited from these changes (Mackintosh et al., 2002). These children exhibited significantly better growth outcomes than their counterparts in the control community also assessed at follow-up (Mackintosh et al., 2002).

Lapping *et al.* (2002) also examined the validity of the positive deviance methodology to community nutrition studies, making a comparison against a conventional case-control methodology to determine whether a positive deviance-informed study could add usefully to more traditional approaches. Both approaches were implemented in parallel, to identify determinants of child nutritional status in a low-income Afghan refugee community in Pakistan (Lapping et al., 2002). The study found that, while both approaches identified key determinants of good nutritional status in low-income families (some overlapping), the positive deviance approach alone provided further insights into more complex behaviours (e.g. mother's responses to a child refusing food and a child's daily food consumption pattern) that impacted on good nutritional status despite low-income (Lapping et al., 2002). Additively, the case-control study identified practices related to structural mechanisms (e.g. regular health clinic immunisations and growth monitoring) that were associated with good nutritional status for these children (Lapping et al., 2002). These findings suggest that the positive deviance approach can make valuable contributions to traditional studies of nutritional status, as a positive deviance methodology can offer important insights quickly into intractable situations of nutritional vulnerability, even when only "minimal baseline malnutrition data" are available (Lapping et al., 2002).

Positive deviance as applied to this study

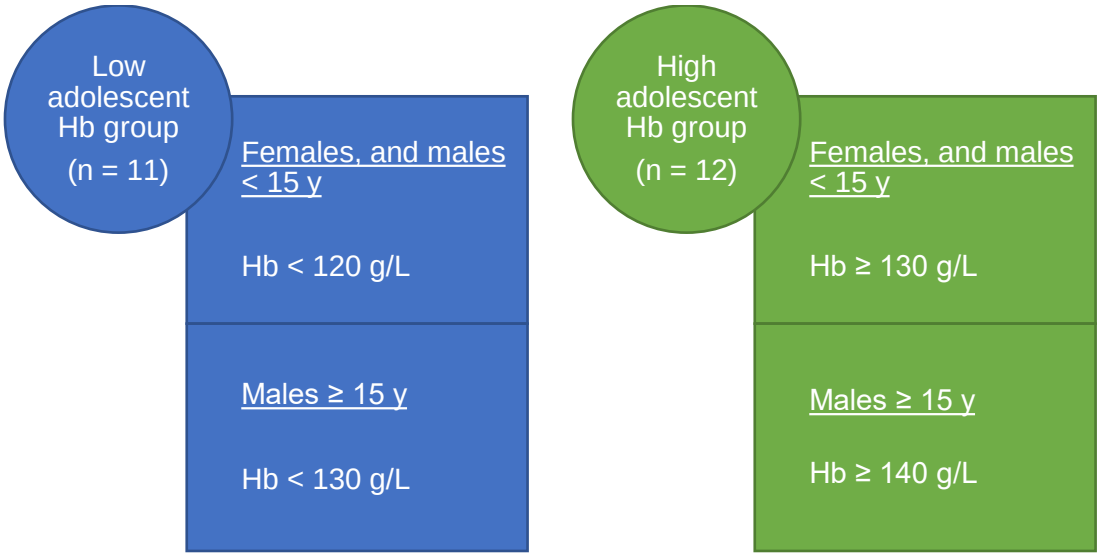
There are currently no published nutrition data (i.e. biochemical, dietary or anthropometric data) for any adolescent Palestinian refugees at the Beddawi refugee camp. This community experiences high rates of food insecurity and, given the high rates of child and adolescent poverty within this camp, these children and adolescents are at high risk for malnutrition and associated poor health (Ghattas et al., 2015; Habib et al., 2014b).

The major aims of this study were to begin to characterise the anaemia and diet diversity status of adolescents at the Beddawi camp and, further, to describe plant-based food preparation in households at the camp. Given the increased vulnerability of adolescents at the camp to anaemia, low diet diversity and high plant-food reliance, another aim of this study was to examine

whether FPs in households with anaemic compared to non-anaemic adolescents valued plant foods differently. Qualitative analysis was performed in order to evaluate this from FP interview data. The research question posed for this part of the study was: “Are plant foods valued differently by food preparers in households with anaemic compared with non-anaemic adolescents?”

Reflexive thematic analysis (explained further below) within a positive deviance framework was performed in this study to begin to answer this question. The framework was applied once data were collected, i.e. retroactively. The goal of this analysis was to draw out major themes within FP responses to the question: “What about plant-based foods is important to you?” This question was asked at the end of the plant food preparation section of interviews and was intended to capture FP views on the place of plant-based foods in their households. Ahead of analysis, transcribed responses to this question were separated into two groups with high food insecurity prevalence (see **Table 31** in **Chapter seven: Qualitative results**): [1] those from FPs in households with high-Hb adolescents (non-anaemic) and [2] those from FPs in households with low-Hb (anaemic) adolescents. High adolescent Hb was assigned if the participating adolescent from the household returned a Hb result at least 10 g/L higher than the anaemia cut-off for their age and sex (as per WHO 2011), while low adolescent Hb was assigned if the participating adolescent returned a Hb result lower than the cut-off for their age and sex, designating them as ‘anaemic’ by the same WHO 2011 criteria (see **Figure 10** below). Themes developed for each group throughout the analysis process were reviewed by Dr Linda Murray. Once the developed themes were finalised, comparisons were made between the two groups to examine whether differences in valuation of plant-based foods could be identified between them. The results of this analysis process are reported in **Chapter seven: Qualitative results**.

Figure 10: Positive deviance-guided group division for reflexive thematic analysis



Reflexive thematic analysis

Background

Reflexive thematic analysis is a qualitative analytic approach that encourages flexible, recursive engagement with qualitative data to produce codes and themes from within a dataset. It accepts the subjectivity of the researcher performing it as an integral part of data organisation and interpretation processes (Braun & Clarke, 2021b). Reflexive thematic analysis is distinguished primarily from two other dominant styles of thematic analysis: coding reliability thematic analysis and codebook thematic analysis (Braun & Clarke, 2019). Coding reliability thematic analysis involves multiple researchers and sets out to achieve consensus on codes and themes generated during preliminary data analysis (Braun & Clarke, 2021a). Researchers are then tasked with identifying information in subsequent data that have been agreed to belong to a particular code or theme category, based on discussion and determination in those early phases of analysis (Braun & Clarke, 2021a). Reliability – here, a measure of the degree to which codes and themes were similarly assigned by multiple researchers independently – is determined through a statistical test (Braun & Clarke, 2021a). Codebook thematic analysis involves the development of a codebook over the entire course of analysis (Braun & Clarke, 2021b). Unlike the coding reliability approach, the codebook is developed in an additive manner, with individual researchers coding different parts of a dataset independently (Braun & Clarke, 2021a). While consensus is not an aim of this approach, the accessibility of the developing codebook to all involved

researchers is meant also to guide the construction of codes and themes (Braun & Clarke, 2021a). Reflexive thematic analysis, on the other hand, does not involve the creation of a codebook, nor does it seek to achieve consensus on codes and themes between multiple researchers. Codes and themes are developed iteratively through the subjective lens of the researcher once all data are collected (Braun & Clarke, 2021a). In reflexive thematic analysis, themes are generated by positioning codes around a 'central organising concept' (Braun & Clarke, 2021a; Byrne, 2021). The process involves six general phases: data familiarisation, initial code creation, prospective theme generation, prospective theme review, theme name finalisation, and reporting (Braun & Clarke, 2021b; Byrne, 2021). Progression through these phases in not linear, and throughout the entire process – including during the reporting phase – a researcher is encouraged to reflect on the meaning they are constructing from the data and make updates as necessary (Braun & Clarke, 2021a; Byrne, 2021).

Reflexive thematic analysis as applied to this study

Reflexive thematic analysis was elected to organise and interpret this aspect of the qualitative data in this study. The flexibility of this approach, along with its suitability for data-led (i.e. inductive) code and theme construction made it a suitable choice for the analysis and interpretation of the personal perspectives of FPs in this community, particularly given no existing data on plant-food importance were available for this group.

Reflexive thematic analysis as outlined in a worked example by Byrne 2021 guided the analysis process in this study. An overview of the process is set out below.

Data familiarisation

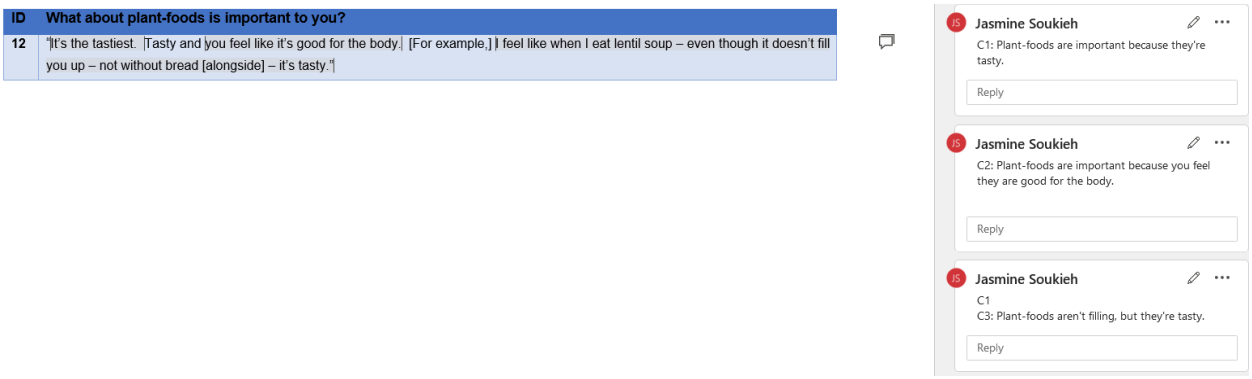
Data familiarisation was a recursive and iterative process. Translated transcribed responses were read through several times during this stage. Familiarisation over several reads allowed for preliminary semantic engagement with keywords and ideas contained in responses in preparation for subsequent code creation.

Initial code creation

Initial code creation involved both semantic and latent coding. Semantic coding is descriptive and refers to the production of codes from text-level meaning only (Byrne, 2021). Latent coding, on the other hand, adds an additional element of analysis to coding, whereby the researcher is encouraged to delve further into the content of responses to interpret potential meaning and assumptions driving participant responses (Byrne, 2021). Responses for low and high adolescent Hb groups were first colour-coded (blue for 'low' and green for 'high') to ensure easy tracking

throughout the analysis process. Next, segments of a response that engaged with an aspect of the interview question were tagged and assigned a code systematically (see **Figure 11** for sample working; see **Appendix II** for full working). Codes produced were predominantly semantic. Latent codes were distinguished from these through the inclusion of an additional note.

Figure 11: Sample coding from transcript text



Original codes were compiled as they were created, and quotes associated with these codes were organised alongside them for ease of reference (see **Table 23** and **Table 24** for sample working; see **Appendix II** for full working). Many codes were generated at this stage that would later be grouped together into themes based on the similarity of their interpreted semantic or latent meanings.

Table 23: Sample initial code summaries with associated quotes – low adolescent Hb group

Initial code	Associated excerpt (ID)
C1: Plant-foods are important because they're tasty.	"It's the tastiest." (12) "I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12) "In terms of my kids, the most important thing is that they like it." (64)
C2: Plant-foods are important because you feel they are good for the body.	"…you feel like it's good for the body." (12)
C3: Plant-foods aren't filling, but they're tasty.	"I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12)

Initial code	Associated excerpt (ID)
C6: Plant-foods are important because of their taste, not nutritional factors.	"What we feel like or enjoy, I'll prepare. It's not so much that it is nourishing or beneficial or anything – do you get me? That's how we're accustomed..." (28)
C7: Plant-foods are important because they promote kids' growth.	"…what I like is to see them [kids] growing tall…" (30)
C15: Home-cooking is preferable to take-out; (Latent) plant-foods are associated with home-cooking and its perceived benefits.	"And I don't like for them to eat from outside [the house]. Like… whatever they request, I make it for them. For example, things like 'الكريسبس\Crispy (fried battered chicken)' – I make it for them at home, myself." (47) "… It even gives you a feeling of home security; in that *you've* made a nutritional meal – you're reassured; you know what you're feeding your kids." (64)

Table 24: Sample initial code summaries with associated quotes – high adolescent Hb group

Initial code	Associated excerpt (ID)
CA: Plant-foods are important because they are better than meat foods.	"They say that plant foods are usually better than meat foods – that's what I hear." (9) "More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… " (11) "But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken…" (54)

Initial code	Associated excerpt (ID)
CC: Plant-foods are important because they strengthen your blood.	"… it strengthens your blood – [if you have it] you won't get anaemia." (11) "In that, I guess, it's good for your health – maybe, in terms of, blood – " (61) "When I find that there is a deficiency in their blood – the kids…" (71)
CD: Plant-foods are important because they prevent anaemia.	"… it strengthens your blood – [if you have it] you won't get anaemia." (11)
CG: Plant-foods are important because they are enjoyed.	"They love it a lot, and I prepare it a lot…" (27) "…the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71)
CH: Plant-foods are important because, as a food group, they contribute the most iron to the diet.	"It strengthens the iron in them [i.e. kids]… this [food type] does it the most… e.g. spinach, spinach increases their iron; I like for them to eat spinach." (27)
CI: Plant-foods are important because they contribute iron for kids' growth and development.	"In terms of kids' growth, their development. Vegetables are beneficial/wholesome – it's iron for their health." (34)

Prospective theme generation

Prospective themes were generated by grouping codes around a 'central organising concept'. A central organising concept refers to the core uniting idea that ties codes positioned around it together (Byrne, 2021). Semantic and latent codes that were interpreted as sharing meaning were grouped together at this stage (see **Table 25** and **Table 26** for sample working; see **Appendix II** for full working). The process of grouping codes and labelling central organising concepts was recursive and iterative.

Table 25: Sample working of prospective theme development from initial codes – low adolescent Hb group

Central organising concept/prospective theme	Codes	Quotes
Taste	C1: Plant-foods are important because they're tasty. C3: Plant-foods aren't filling, but they're tasty. C6: Plant-foods are important because of their taste, not nutritional factors.	"It's the tastiest." (12) "I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12) "In terms of my kids, the most important thing is that they like it." (64) "What we feel like or enjoy, I'll prepare. It's not so much that it is nourishing or beneficial or anything – do you get me? That's how we're accustomed..." (28)

Table 26: Sample working of prospective theme development from initial codes – high adolescent Hb group

Central organising concept/prospective theme	Codes	Quotes
Plant foods are better than meat foods	CA: Plant-foods are important because they are better than meat foods.	"They say that plant foods are usually better than meat foods – that's what I hear." (9) "More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… " (11) "But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken…" (54)

Initially, six prospective themes were generated from these groupings for the low adolescent Hb group and seven for the high adolescent Hb group (see **Figure 12** and **Figure 13**). An additional miscellaneous theme category was also produced for each group to contain responses that were determined to engage latently with the interview question. This was done to ensure adequate tracking of latent code interpretation given their more implicit engagement with the question.

Figure 12: Preliminary thematic map – low adolescent Hb group

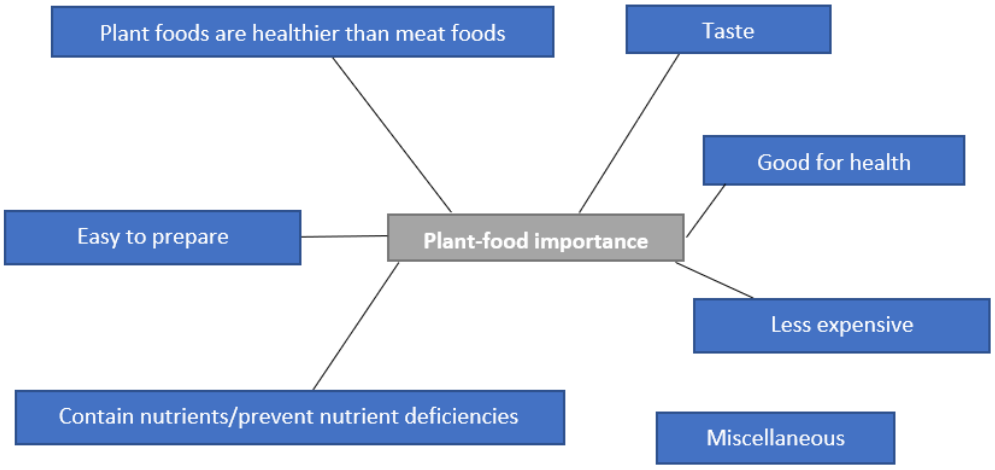
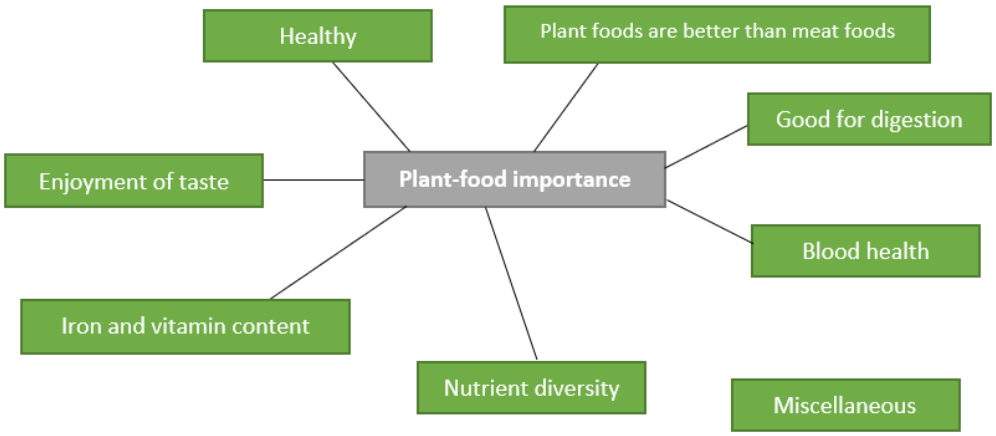


Figure 13: Preliminary thematic map – high adolescent Hb group



Prospective theme review

Once prospective themes were generated, they were reviewed in relation to certain criteria, in order to ensure that codes, subthemes and themes were consistently and appropriately

distinguished from one another. The key criteria that were examined to accomplish this were (Byrne, 2021):

[1] Whether a theme had clear boundaries or not, which included an examination of what a theme did and did not include;

[2] Whether a theme was thin or thick, which referred to the degree to which it provided meaningful data for answering the interview question (and, by extension, the research question); and

[3] Whether the theme was coherent or not, which assessed the degree to which responses were all engaging with aspects of the same central organising concept.

These criteria were assessed for each prospective theme generated (see **Table 27** and **Table 28** for sample working; see **Appendix II** for full working). Again, the process was recursive and iterative. Codes, quotes and themes were renegotiated and reorganised as necessary to produce themes with clear boundaries, and to ensure awareness of the thinness or thickness and coherence of the themes generated.

Table 27: Sample prospective theme review – low adolescent Hb group

Prospective theme	Refined central organising concept	What does the theme include vs. exclude? Clear boundaries?	Thin or thick theme?	Coherence?	Refined theme name
Taste	Choosing to prepare plant-foods in the household is done predominantly based on taste preferences	- Includes references to taste and enjoyment of plant-foods and the precedence of that over other points of importance - Excludes responses that give health, nutrition and economic rationales predominance over taste - Boundaries are pretty clear: One quote also includes reference to health (ID12); rationale for including ID12 here: FP refers to 'taste' 3 times, 'good for body' once, 'not filling' once and the concept of taste brackets other information	Thick - Meaningful data for answering RQ are contained within the theme - A few respondents (3/11) brought this up	Theme is coherent - Quotes refer to taste and distinguish this from other potential considerations - Where other rationales are given, taste takes precedence or other rationale is contextualised within overall taste rationale (e.g. ID12)	Predominance of taste preferences when valuing plant-foods

Table 28: Sample prospective theme review – high adolescent Hb group

Prospective theme	Central organising concept	What does the theme include vs. exclude? Clear boundaries?	Thin or thick theme?	Coherence?	Refined theme name
Plant foods are better than meat foods **+** **SUBTHEME 1: Blood health** **+** **SUBTHEME 2: Good for digestion**	Plant-foods are an important complementary group to meat foods because they promote general health in their own ways	- Includes respondents making comparisons between plant and meat foods and/or electing plant-foods over meat foods, in terms of importance – with or without additional comments on health promotion extensions to this comparison - Excludes nutrient references that are not tied to general health, blood health or digestion outcomes	Thick - Meaningful data for answering the RQ are contained within the theme - General situating of plant-foods in comparison to meat foods is explored in a few responses (3/12), and further detail in the form of distinct subthemes is explored by a few other respondents (4/12)	Theme is coherent - Quotes all draw a comparison between plant and meat foods - Respondents offer a range of rationales in making their comparisons	Plant-foods are an important food category and contribute differently when compared to meat foods
SUBTHEME 1: Blood health	Plant-foods are important because they promote blood health	- Includes responses that discuss plant-food improvement of blood health and/or anaemia prevention, contextualised within a plant-food—meat-food comparison - Excludes mentions of specific nutrients as contributing to blood health or anaemia prevention - Boundaries are clear: the subtheme within its parent theme is distinct from other themes; the blood health subtheme is distinct from the digestion subtheme	Thick - Contains meaningful data for answering RQ - A few respondents (4/12) gave elaborated responses on this	Subtheme is coherent - Quotes all discuss blood in relation to plant-food importance to health without also making reference to specific nutrients to draw the complete link between plant-food—nutrients—blood health	Plant-foods promote blood health

Prospective theme	Central organising concept	What does the theme include vs. exclude? Clear boundaries?	Thin or thick theme?	Coherence?	Refined theme name
SUBTHEME 2: Good for digestion	Plant-foods are easy on the stomach and good for the digestive system	- Includes rationales on plant-food contribution to digestion comfort, as distinct from other health or nutrition outcomes, contextualised within a plant-food—meat-food comparison - Excludes health or nutrition explanations for plant-food value - Boundaries are clear: the subtheme within its parent theme is distinct from other themes; the digestion subtheme is distinct from the blood health subtheme	Thin - Contains meaningful data for answering RQ - Mentioned only twice (2/12) and briefly, at that	Subtheme is coherent - Quotes are consistent in rationalising plant-food importance in relation to digestion within the context of a comparison of the plant-food group with the meat food-group	Plant-foods are good for digestion

Theme name finalisation

Over the course of the review process, themes were updated and quotes and codes were reorganised to produce finalised themes for each group (see **Table 29** and **Table 30**). Thematic maps were also updated throughout this renegotiation of themes to produce finalised maps (see **Figure 14** and **Figure 15**).

Figure 14: Final thematic map – low adolescent Hb group

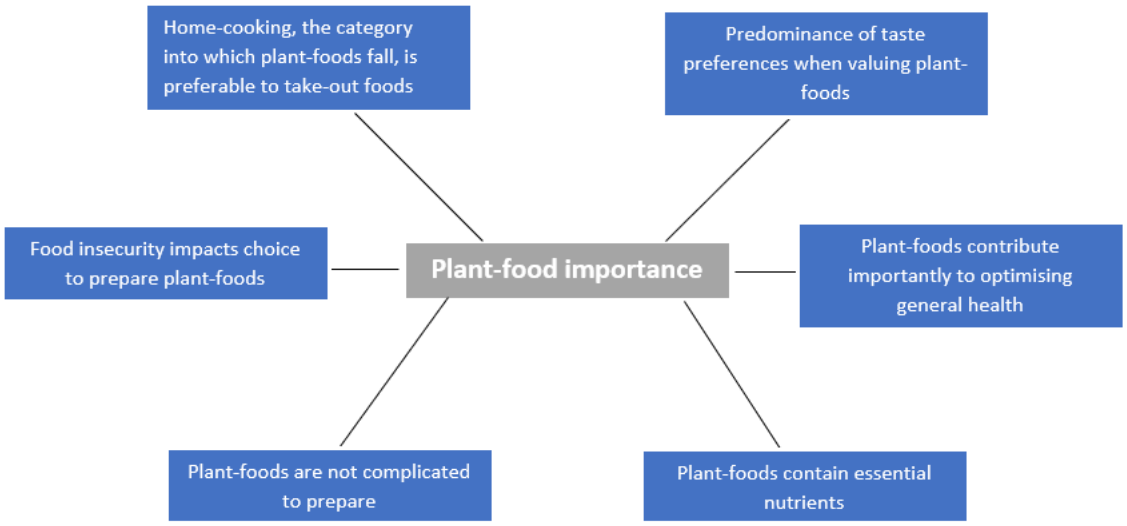
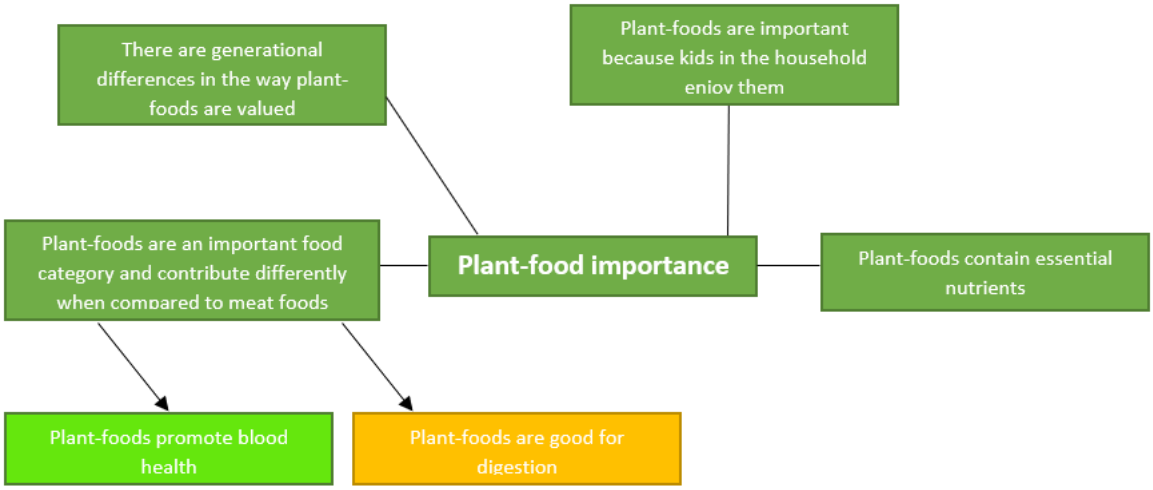


Figure 15: Final thematic map – high adolescent Hb group



The final number of themes generated for the low and high adolescent Hb groups were 6 and 4, respectively. Two subthemes were also generated for the high adolescent Hb group.

Table 29: Theme development summary: Prospective to final – low adolescent Hb group

Prospective theme	Updated theme	Final theme
Taste	Predominance of taste preferences when valuing plant-foods	Predominance of taste preferences when valuing plant-foods
Good for health	Plant-foods contribute importantly to optimising general health	Plant-foods contribute importantly to optimising general health
Plant foods are healthier than meat foods	Cut as independent theme; codes and quotes subsumed under *Good for health* prospective theme	N/A
Contain nutrients/prevent nutrient deficiencies	Plant-foods contain essential nutrients	Plant-foods contain essential nutrients
Easy to prepare	Plant-foods are not complicated to prepare	Plant-foods are not complicated to prepare
Less expensive	Food insecurity impacts choice to prepare plant-foods	Food insecurity impacts choice to prepare plant-foods
Miscellaneous	Home-cooking, the category into which plant-foods fall, is preferable to take-out foods	Home-cooking, the category into which plant-foods fall, is preferable to take-out foods

Table 30: Theme development summary: Prospective to final – high adolescent Hb group

Prospective theme	Updated theme	Final theme
Healthy	Cut as independent theme; quotes subsumed under *Blood health* and *Iron and vitamin content* prospective themes	N/A
Enjoyment of taste	Plant-foods are important because kids in the household enjoy them	Plant-foods are important because kids in the household enjoy them
Iron and vitamin content	Plant-foods contain essential nutrients	Plant-foods contain essential nutrients
Nutrient diversity	Cut as independent theme; codes and quotes subsumed *Iron and vitamin content* prospective theme	N/A
Plant foods are better than meat foods	Plant-foods are an important food category and contribute differently when compared to meat foods	Plant-foods are an important food category and contribute differently when compared to meat foods - Contains two subthemes: 1) Plant-foods promote blood health 2) Plant-foods are good for digestion
Blood health	Plant-foods promote blood health	Subtheme within *Plant-foods are an important food category and contribute differently when compared to meat foods* parent theme
Good for digestion	Plant-foods are good for digestion	Subtheme within *Plant-foods are an important food category and contribute differently when compared to meat foods* parent theme
Miscellaneous	There are generational differences in the way plant-foods are valued	There are generational differences in the way plant-foods are valued

Reporting

Reporting on the final list of themes and subthemes produced from this reflexive thematic analysis is done in the next chapter.

CHAPTER SEVEN: QUALITATIVE RESULTS

The qualitative findings of this study are reported on in this chapter. In particular, the themes produced through the reflexive thematic analysis outlined in the previous chapter are described. Themes were generated from food preparer (FP) responses to the interview question: "What is the importance of plant-based foods to you?" In this chapter, an overview of the broad demographic features of the low and high adolescent Hb groups is first set out. This is followed by a report on the themes produced from the analyses undertaken for each group.

Demographic features: Low and high adolescent Hb groups

Guided by a positive deviance approach, FP responses were divided into two groups, both with high food insecurity but that differed in terms of adolescent Hb outcomes (i.e. low [n = 11] and high [n = 12]). Low adolescent Hb concentration was assigned for adolescent boys aged < 15 y and all girls who returned a Hb result < 120 g/L. For adolescent boys ≥ 15 y, low Hb was assigned if a Hb result < 130 g/L was returned. High adolescent Hb concentration was assigned for boys aged < 15 y and all girls who returned a Hb result ≥ 130 g/L, and for adolescent boys aged ≥ 15 y who returned a Hb result ≥ 140 g/L. **Table 31** summarises demographic features of each group. Adolescent sex ratios were different between the two groups; girls made up the majority in the low Hb group, while boys made up the majority in the high Hb group. All boys in the low adolescent Hb group were < 15 y. The median ages of adolescents in each group were 14 and 13 for low and high, respectively. The median household size for each group was 5, though households of adolescents with high Hb had a higher median number of household members under the age of 18 y (3 compared to 1). The median highest grade achieved by FPs in each group was 9. Food insecurity was high in both groups, though it was slightly higher in the low adolescent Hb group (82% compared to 75%).

Table 31: In-group demographic features of low and high adolescent Hb groups

In-group feature	Low adolescent Hb (n = 11)	High adolescent Hb (n = 12)
Sex ratio (boys:girls)	4:7	9:3
Age range (y)	M: 11-14 F: 12-19	M: 10-16 F: 12-18
Group median age (y)	14	13
Median total in household	5	5
Median total in household <18 y	1	3
Median FP highest grade reached	9	9
% food insecure	82% (9 of 11)	75% (9 of 12)

Theme reporting: Low and high adolescent Hb groups

The research question posed for this part of the study was: "Are plant foods valued differently by food preparers in households with anaemic compared with non-anaemic adolescents?" In order to answer this question, themes for each group that were produced from FP responses to the interview question about plant-food valuation are reported on separately for each group (for the low adolescent Hb group, followed by the high) in this chapter. Themes are organised in this report by thickness, i.e. the degree to which responses positioned around the same central organising concept engaged directly with the interview question. Themes built up that contained several and/or more detailed FP responses are prioritised here ahead of those with fewer or more sparse responses, though all responses that engaged directly with the interview question and, as such, offered insight into answering the research question have been included irrespective of thickness. Within theme descriptions, semantic meaning is reported ahead of latent. Comparisons of themes across the two groups are made at the end of this chapter.

Themes generated from FP responses: Low adolescent Hb group

Theme 1: Plant foods contribute importantly to optimising general health

Quotes tied to the central organising concept of plant-food benefit to general health were the most abundant of all responses in the low adolescent Hb group (see **Table 32**). As such, the theme "Plant foods contribute importantly to optimising general health" was allocated Theme 1 for the low adolescent Hb group. Respondent quotes that were organised into this theme discussed the benefits of plant foods in comparison to other food categories (i.e. meat foods), and explained that plant foods contributed to optimising general health.

Table 32: Key quotes for Theme 1 – Low adolescent Hb group

Theme 1: Plant foods contribute importantly to optimising general health
"…you feel like it's good for the body." [12]
"It's healthier than meat or chicken – healthier than anything else – lots healthier." [16]
"For me, the thing I like so much is to… what I like is to see them [kids] growing tall… a bit… so that, for example, if I have them do tests, they won't have any deficiencies… I want for them to be healthy – I don't want them to become overweight…" [30]
"Firstly, its importance is that it's beneficial for the body; it's healthy… the most important, important thing is that it's beneficial/wholesome." [31]
"And secondly, it's nourishment/nutrients for them [the kids]. Like… they like chicken and meat and fish, the kids, more than they like vegetables. But I try [to say] 'no'… vegetables…" [42]
"They contain a lot of beneficial elements for the body, plant foods." [48]
"They're beneficial for a child's body." [55]
"I feel that its nutritional contents are beneficial…" [64]

Respondents explained that plant foods were healthier than other food groups, and drew comparisons specifically with meat foods (Table 32, [12]). The sentiment that plant foods had important contributions to make to general health was noted in responses that gave plant foods precedence over meat foods (Table 32, [16, 42]). One respondent remarked that, although her children preferred meat foods, she encouraged them instead to have "vegetables" (Table 32, [42]). These responses, which separate another important food group – meat foods – from plant

foods, suggest that plant foods, as a category, have an important and unique place in the households that utilise them.

One dimension of their importance, as stated by respondents, was that they offered nourishment and promoted general health. Keywords identified in FP responses that contributed to the generation of this theme were: “good”, “healthy”, “beneficial or wholesome” and “nutritious or nourishing”[6]. There was consensus among these respondents that plant foods promoted health. Health benefits were described generally and tied specifically to plant foods as a food category (Table 32, [42, 48]).

Respondents additionally described the benefits of plant foods to children’s health (Table 32, [30, 42, 55]. One respondent offered additional insight into the aspects of her children’s health that she associated with plant food consumption: “For me, the thing I like so much is to… what I like is to see them [kids] growing tall… a bit… so that, for example, if I have them do tests, they won’t have any deficiencies… I want for them to be healthy – I don’t want them to become overweight…” (Table 32, [30]). Her response communicates that she values plant foods for the role they play in promoting linear growth, combating nutrient deficiencies and mitigating against excessive weight gain in her children.

In summary, Theme 1 comprises a key dimension of the response to the question of plant food value to FPs in the low adolescent Hb group; it offers that plant foods are important because they optimise general health. Responses that produced this theme described plant foods as being healthier than meat foods, and beneficial for the body. Descriptions of benefits were mostly general, though they were also described more specifically as being important for a child’s body in terms of nourishment and growth.

Theme 2: Predominance of taste preferences when valuing plant foods

Plant-food valuation based on taste preferences was assigned Theme 2, as quotes contributing to this theme’s development were the next most abundant in FP responses in the low adolescent Hb group (see **Table 33**). Responses here explored the dimension of taste. Plant foods were described here by FPs as being important because members of the household enjoyed them.

[6] The original terms in Arabic to describe plant foods positively in relation to health were: منيحة, صحّيّة, فائدة and مغذّية (mnīḥa [good], ṣiḥḥiyya [healthy], fāᵓida [beneficial or wholesome] and mughadhiyya [nutritious or nourishing]).

Table 33: Key quotes for Theme 2 – Low adolescent Hb group

Theme 2: Predominance of taste preferences when valuing plant foods
“It’s the tastiest. Tasty and you feel like it’s good for the body. [For example,] I feel like when I eat lentil soup – even though it doesn’t fill you up – not without bread [alongside] – it’s tasty.” [12]
"What we feel like or enjoy, I’ll prepare. It’s not so much that it is nourishing or beneficial or anything – do you get me? That’s how we’re accustomed..." [28]
“In terms of my kids, the most important thing is that they like it.” [64]

Taste was discussed in two key ways in these FP responses. The sentiment that plant foods were tasty was expressed explicitly as a reason to prepare them (Table 33, [12]), as was the sentiment that taste dictated whether a plant food was prepared, whether or not it was beneficial for health or nutrition (Table 33, [28, 64]).

Responses contributing to this theme emphasised the importance of the taste dimension for FPs in this group during decision-making surrounding the preparation of plant foods in the household. While one respondent also communicated a sense that plant foods contributed positively to health (Table 33, [12]), her repetition of the term “tasty” and her bookending of the health comment with taste comments has been interpreted to suggest that the taste dimension predominated in her valuation of plant foods. She further explained that plant foods were not filling, which she put forward as a caveat to their value, before continuing on to say that she would still prepare them because of their taste, and would compensate for the lack of satiety by including additional elements (i.e. bread) alongside the plant-food meal (Table 33, [12]).

There was also the suggestion in these responses that enjoyment of the meal was so important that nutritional or health benefits were not part of rationalising the inclusion of plant foods in the food landscape of the household (Table 33, [28]). Enjoyment of a meal, irrespective of its other benefits or shortcomings, was the primary point of valuation of a food – of which plant foods were one type. This was expressed directly: "What we feel like or enjoy, I’ll prepare. It’s not so much that it is nourishing or beneficial or anything – do you get me? That’s how we’re accustomed..." (Table 33, [28]), and more implicitly: “In terms of my kids, the most important thing is that they like it” (Table 33, [64]). The value – or lack thereof – then, of plant foods to these FPs lay in the degree to which these foods were enjoyed in the household.

In summary, Theme 2 contributes a further dimension to answering the question of plant-food importance for FPs in the low adolescent Hb group; it offers that if a plant food is tasty, it will be prepared in the household, and that taste prevails over the health or nutrition value that plant foods might also provide. It also offers, more implicitly, that if a plant food is not enjoyed in the household, it will not be prepared, whether it contributes positively to health or not.

Theme 3: Plant foods contain essential nutrients

Nutrient content was another reason FPs in the low adolescent Hb group valued plant foods. Theme 3 collects respondent quotes around the concept of essential nutrients and their presence in these foods (see **Table 34**). The nutrients identified by FPs in this group were iron and vitamins.

Table 34: Key quotes for Theme 3 – Low adolescent Hb group

Theme 3: Plant foods contain essential nutrients
"In [their] iron… because of the iron." [41]
"They're beneficial for a child's body. They have iron… they have vitamins… they have stuff [that's necessary] for a child… as in – a child ought to eat things like this." [55]

While coherent, and while offering additional insight into FP valuation of plant foods, this theme is thin. Two quotes attributed value to plant foods based on their nutrient contents (Table 34, [41, 55]). The iron and vitamin content of plant foods was associated with child health by one FP, and the essentiality of these elements to health was also communicated: "They're beneficial for a child's body. They have iron… they have vitamins… they have stuff [that's necessary] for a child… as in – a child ought to eat things like this" (Table 34, [55]). Iron was cited by another FP in this group as the point of valuation of plant foods, for her, without elaboration (Table 34, [41]).

In summary, Theme 3 responds to the question of plant food value to FPs in the low adolescent Hb group by offering that these foods contain essential nutrients, and that these nutrients are beneficial for a child's health.

Theme 4: Home-cooking, the category into which plant foods fall, is preferable to take-out foods

Theme 4 comprises quotes interpreted to contain more implicit and inferred meaning in response to the interview question on plant-food value to FPs in the low adolescent Hb group (see **Table 35**). Respondents contributing quotes to this theme's development rationalised the importance

of plant foods in terms of their categorisation as 'meals prepared at home'. Plant-food value, then, was interpreted here to be an extension of the non-specific benefits conferred by home-cooking.

Table 35: Key quotes for Theme 4 – Low adolescent Hb group

Theme 4: Home-cooking, the category into which plant foods fall, is preferable to take-out foods
"… I don't like for them to eat from outside [the house]. Like… whatever they request, I make it for them. For example, things like 'الكريسبس/Crispy (fried battered chicken)' – I make it for them at home, myself." [47]
"It even gives you a feeling of home security; in that ***you've*** made a nutritional meal – you're reassured; you know what you're feeding your kids." [64]

Rather than explaining the importance of plant foods – specifically – to them, some FPs provided insight into a perception that plant foods, for them, belonged to the broader category of 'home-cooked foods'. Home-cooked foods were then distinguished from take-out foods. In one response, for example, the respondent answered the question "What is the importance of plant-foods to you?" by speaking of home-cooking and her preference that her children consume the home-prepared version of a meal – whatever the meal – rather than the take-out version: "… I don't like for them to eat from outside [the house]. Like… whatever they request, I make it for them. For example, things like 'الكريسبس/Crispy (fried battered chicken)' – I make it for them at home, myself" (Table 35, [47]). As the respondent invokes home-cooking in response to a question about plant-food importance, it has been interpreted that she links the two categories, i.e. that plant foods are understood by her to be contained within the 'home-cooking' category. Subsequently, she describes a meat food, not a plant food, to support her point, further delineating that 'home-cooking' and 'take-out' are the categories she is engaging with, rather than plant compared with other food types.

Another respondent described the reassurance she felt at preparing a meal at home: "It even gives you a feeling of home security; in that ***you've*** made a nutritional meal – you're reassured; you know what you're feeding your kids" (Table 35, [64]). In her response, she too situates plant-foods within the home-cooking category and positions it in relation to take-out foods to explain her stance on plant-food value. In her response, home-cooking is then associated with the general benefits she subsequently describes. The benefits she associates with home-cooking include nutrition considerations, but also extend beyond those to a sense of satisfaction at having prepared a meal personally at home for her children. Additional benefits may also implicitly be contained in these responses; there is the suggestion that part of the value of home-cooking

extends to food safety considerations, as the respondent expressed relief at having ultimate oversight of the food preparation process (Table 35, [64]).

In summary, Theme 4 comprises responses that more implicitly provide insight into the valuation of plant foods by FPs in the low adolescent Hb group. FPs reframed the interview question, and plant foods became a category with less meaning than a broader category into which they were interpreted to be placed – home-cooking. FPs offered, then, that home-cooking, the category to which plant foods belong, is preferable to take-out because of nutrition and, possibly, food safety considerations. These benefits were perceived to be conferred by home preparation of foods, rather than being associated with plant foods themselves.

Theme 5: Plant foods are not complicated to prepare

Theme 5 is another thinner theme, in that only one quote contributed to its development (see **Table 36**). It has been included as a theme, however, as it communicates a distinct additional rationale to plant-food importance in the low adolescent Hb group. Specifically, it explains that one further reason that plant foods are valued in the low adolescent Hb group is because their preparation is uncomplicated.

Table 36: Key quote for Theme 5 – Low adolescent Hb group

Theme 5: Plant foods are not complicated to prepare
"…its cooking is uncomplicated; it's not one of those cooking [styles] that is – in truth – burdensome for you to prepare. " [31]

Plant foods, as viewed by this FP, were considered straight-forward to prepare (Table 36, [31]). The use of the terms "uncomplicated" and "burdensome" in the quote have been interpreted to refer to a lack of time and/or energy to prepare more complicated meals. The response may also refer more implicitly to limitations on personal food preparation experience or expertise, and/or access to this experience or expertise.

In summary, Theme 5 responds directly to the interview question and offers that considerations of FP time, energy and expertise influence perceptions of plant-food value and, subsequently, their inclusion in the food landscape of a household within the low adolescent Hb group.

Theme 6: Food insecurity impacts choice to prepare plant foods

The final theme generated from responses made by FPs in the low adolescent Hb group is also thin; again, a single, brief quote contributed to its development (see **Table 37**). As with Theme 5,

this theme contributes insight into the interview question along a distinct dimension. It highlights that food security plays a role in FP valuation of plant foods.

Table 37: Key quote for Theme 6 – Low adolescent Hb group

Theme 6: Food insecurity impacts choice to prepare plant foods
"Firstly, it's less expensive, in truth." [42]

In her response, which also included reference to the nutritional importance of plant foods (Table 32, [42]), this respondent communicated that plant foods were a "less expensive" type of food (Table 37, [42]). She placed this rationale ahead of her subsequent nutrition rationale, which has been interpreted to mean that financial considerations were at the forefront of her decision-making surrounding food preparation in her household. Her response indicates some degree of household food insecurity. As such, opting to prepare plant foods has been interpreted here to mean that food insecurity is part of the reason that these foods are prepared by this FP.

In summary, Theme 6 contributes a final, distinct response to the question of plant-food importance to FPs in the low adolescent Hb group; it offers that plant foods are valued because they constitute a cost-effective meal option.

Themes generated from FP responses: High adolescent Hb group

Theme 1: Plant foods are an important food category and contribute differently when compared to meat foods

The central organising concept around which the most quotes were positioned in the high adolescent Hb group was one that contrasted plant foods with meat foods (see **Table 38**). As such, it has been allocated Theme 1 of four themes describing plant food value to FPs in the high adolescent Hb group. FPs contributing quotes that generated this theme discussed plant foods as contributing unique benefits to health and nutrition, thus allocating such foods their own distinct place amongst other important food types (i.e. meat foods). Two subthemes were generated from these quotes (see **Table 38**). Each subtheme addressed a dimension of the specific benefits FPs viewed plant foods, as a food category, as having. The benefits represented in these subthemes are blood health promotion and digestive comfort, respectively.

Table 38: Key quotes for Theme 1, Subtheme 1 and Subtheme 2 – High adolescent Hb group

Theme 1: Plant foods are an important food category and contribute differently when compared to meat foods
"They say that plant foods are usually better than meat foods – that's what I hear." [9]
"More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… " [11]
"But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." [54]
Subtheme 1: Plant foods promote blood health
"More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… it strengthens your blood – [if you have it] you won't get anaemia." [11]
"Whenever I make them, I focus mostly on… in relation to lemon… the blood – e.g. my husband, he would ask me – '[Even] mulūkhiya is eaten with lemon [too]?' I would tell him, 'Anything – add lemon to it – in particular, greens – add lemon to them… because it speeds up absorption in the blood – I know that this is the case.' So he became very keen on it – he's become like me [about including lemon in his meals]." [20]
"In that, I guess, it's good for your health – maybe, in terms of, blood – it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. bāmiya, lūbyā b'banadūra, munazzala…" [61]
"When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." [71]
Subtheme 2: Plant foods are good for digestion
"It's easy on the stomach [i.e. in terms of digestion]…" [11]
"I feel like the body is in need of vegetables, [i.e.] for the digestive system; they have iron, vitamins – not all of it is available just in meats." [66]

Plant foods were described by many respondents in this group as comprising an important food group in their own right (Table 38, [11, 54]). Respondents positioned plant foods in relation to meat foods, identifying them as providing essential nutrients that complemented the nutrients offered in meat foods (Table 38, [54, 66]). In describing the benefits of plant foods to digestion, one respondent remarked: "I feel like the body is in need of vegetables, [i.e.] for the digestive system; they have iron, vitamins – not all of it is available just in meats". She explains that plant foods provide nutrients additional to those available in meats, suggesting that the consumption of

the two food types (plant and meat) together completed the diet and, as such, promoted health (here, digestive health) (Table 38, [66]).

Some respondents reported a belief that plant foods were more important than meat foods, either for their contributions to health (Table 38, [11]) and nutrition (Table 38, [61]), or on the basis of taste preferences (Table 38, [71]). In the quote: "When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]", the respondent describes plant foods implicitly as being an alternative, equal nutrient source to meat foods by invoking plant foods as the food type she draws on to combat nutrient deficiencies in her children who do not enjoy the meat-food source (i.e. chicken) of these nutrients, i.e. the food type she would otherwise prepare to address these deficiencies (Table 38, [71]).

FPs in this group also referred to the impression – not the personal opinion – that plant foods were particularly important, or more important than meat foods (Table 38, [9, 61]). One FP responded that she had heard "that plant foods are usually better than meat foods" (Table 38, [9]), for example. Another FP communicated that she felt her children "should be eating" plant foods, and that she took opportunities to include plant foods in her own diet when possible because of this (Table 38, [61]). Her use of the phrase "I guess" and the word "maybe" have been interpreted to mean that these benefits she was attributing to plant foods were less her personal views and more a communication of a sense – perhaps derived from general family or community consensus – that plant foods were important and ought to be included in a diet.

Subtheme 1: Plant foods promote blood health

Subtheme 1 was developed from quotes contributing also to the development of Theme 1 but that discussed a specific element of detail within that broader theme. Subtheme 1 centres on the role of plant foods in promoting blood health.

Specific mentions of blood health were made in several FP responses from the high adolescent Hb group (Table 38, [11, 20, 61, 71]). Plant foods were described as playing a focal role in preventing anaemia (Table 38, [11]) and combating deficiencies in the blood (Table 38, [71]). They were described by one FP generally as being "good for your health", before she delineated that blood health was the beneficiary of this 'goodness' (Table 38, [61]). Her response seems to be more a hesitant communication of her personal valuation of plant foods, and more a concession that plant foods were deemed as generally important for blood health. An undercurrent of guilt seems also to be contained in her response, in her reflection that: "it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating

it." A sense of responsibility for including plant foods in her and her children's diets comes through in her response.

The distinctive handling (i.e. in food preparation and/or consumption) of plant foods was another dimension also discussed in this group regarding the role of plant foods in contributing to blood health. One FP detailed the role of lemon in promoting speedier absorption in the blood of the contents of plant foods (Table 38, [20]). In her response, she implicitly distinguishes "greens" as containing elements that may be acted upon, i.e. through the co-consumption of lemon, to optimise their absorption in the blood. Her response also communicates the importance to her of promoting this: "Whenever I make them, I focus mostly on… in relation to lemon… the blood…" (Table 38, [20]). Latent meaning has also been interpreted from her response. Her linking of plant foods, blood and the absorption of unspecified elements within these foods has been understood to mean that plant foods, to her, offer important nutrients that are worth extracting as completely as possible because they contribute positively to blood health.

Subtheme 2: Plant foods are good for digestion

Subtheme 2 was thinner than Theme 1 and Subtheme 1. As with other thin themes, it was included here as it contributed a distinct, otherwise-unreported dimension to FP perspectives on plant-food importance. The quotes contributing to the generation of this subtheme communicated that plant foods further promote health as they are easy to digest (Table 38, [11]) and because their nutrient contents (here, iron and vitamins) are beneficial for the digestive system (Table 38, [66]). The implication that the variety of nutrients necessary for digestive health could not be supplied by meat foods alone was also made here (Table 38, [66]), which further delineated the role plant foods, as a food type, were perceived to play in health promotion by FPs in the high adolescent Hb group.

In summary, Theme 1, with its two subthemes, offers that plant foods are valued by FPs from the high adolescent Hb group as a distinct food category; in particular, they were distinguished from meat foods. Plant foods were viewed as making complementary or superior contributions to nutrition and health promotion when compared to meat foods, specifically in the domains of blood and digestive health.

Theme 2: Plant foods contain essential nutrients

Theme 2 in the high adolescent Hb group represents quotes collected around the central organising concept of plant-food nutrient content. Several quotes contributed to the generation of this theme (see **Table 39**). The key nutrients identified by FPs in this group were iron and

vitamins. The nutrients contained in plant foods were also described as being essential for health and, specifically, children's health. FPs in this group further made connections between specific plant foods, nutrients within them and positive health outcomes. While quotes associated with this theme also distinguish plant foods from other food groups and link them to blood health, they differ from the quotes collected in Theme 1 in that they identify specific nutrients within a plant food and tie the presence of those nutrients to the health outcomes mentioned.

Table 39: Key quotes for Theme 2 – High adolescent Hb group

Theme 2: Plant foods contain essential nutrients
"[This way] the children will get a complete diet – in that – they've eaten from this… they've eaten from that… a child ought to consume all the nutrients." [18]
"It strengthens the iron in them [i.e. kids]… this [food type] does it the most… e.g. spinach, spinach increases their iron; I like for them to eat spinach." [27]
"In terms of kids' growth, their development. Vegetables are beneficial/wholesome – it's iron for their health." [34]
"They're rich in iron and vitamins." [36]
"Mallow – blood and iron. Spinach – it's iron. Lentils are also iron. All of them contain vitamins." [54]
"In that it's beneficial in terms of iron etc.; it's healthy – it's beneficial for the body, imperative [for it]." [63]

FPs in this group described plant-food importance in terms of their essential and varied nutrient contents (Table 39, [18, 54, 63]). Mallow, spinach and lentils were identified by FPs in this group as contributing iron to a diet (Table 39, [27, 54]). One FP remarked that she saw plant foods as being particularly well-suited to "strengthening the iron" in her children (Table 39, [27]). These foods were also identified as containing vitamins (Table 39, [27]). Plant foods, more generally, were also identified as being "rich in iron and vitamins" (Table 39 [36]).

The presence of these nutrients in these foods was further linked to health benefits in this group (Table 39, [18, 27, 34, 54, 63]). FPs in this group associated iron with blood and general health (Table 39, [54, 63]). Child health was a particular focus in these responses. Plant foods were valued for their capacity to offer nutrients that ensured children had a "complete diet" (Table 39, [18]). Implicit in this response was a suggestion that in the absence of plant foods, a child's diet

would be missing key nutrients. The iron content of plant foods was also viewed as contributing positively to children's growth and development (Table 39, [34]).

In summary, Theme 2 presents another key dimension for understanding the value of plant foods to FPs in the high adolescent Hb group; it offers that plant foods are important because they contain nutrients that are essential to the diet, in that they promote health. Iron and vitamins were identified specifically as being present in these plant foods, and the iron in these foods was viewed as being beneficial to general health and to children's growth.

Theme 3: There are generational differences in the way plant foods are valued

More indirect responses to the interview question by some FPs in the high adolescent Hb group contributed to the development of Theme 3 (see **Table 40**). This theme centres on the idea that plant foods are valued differently across different generations. The quotes collected to produce this theme demonstrate the view of some FPs that younger generations did not value plant foods as older generations did, and that this meant that they did not eat such foods irrespective of the health and nutritional benefits they might contribute.

Table 40: Key quotes for Theme 3 – High adolescent Hb group

Theme 3: There are generational differences in the way plant foods are valued
"But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." [54]
"In that, I guess, it's good for your health – maybe, in terms of, blood – it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. bāmiya, lūbyā b'banadūra, munazzala…" [61]

Both FPs that discussed this intergenerational difference in plant-food valuation distinguished their generation from their children's. One FP remarked: "But this generation doesn't eat this. It's uncommon for this generation to eat things like this", explaining that her children's generation excluded plant foods from their diets, as a matter of course (Table 40, [54]). She goes on to remark that, in her own generation, plant foods held great importance: "For us, it's the most important" (Table 40, [54]).

Another FP explained that, “even” she – in her generation – did not routinely incorporate plant foods into her diet for a time, and that the place at which she would prepare and consume these foods was her parents’ (Table 40, [61]). It has been interpreted from this inclusion of an additional generation (i.e. the parents of this FP) that the intergenerational differences being described extend to these FPs’ generations too, and that the view expressed here is that plant foods have become devalued more and more across generations, i.e. from the FPs’ parents’ generation, to the FPs’ generation and then to their children’s.

These quotes have been interpreted to communicate latent meaning, too. Specifically, they have been understood to suggest that whether or not plant foods contribute valuably to health and nutrition and whether or not FPs value them, if subsequent generations do not value them they cannot become part of those generations’ diets.

In summary, Theme 3 highlights broader context into which the interview question might be placed. It offers that plant-food valuation is generation-dependent and that plant-food importance has decreased the further from earlier generations current generations become. It further suggests that this devaluation of plant foods across generations undermines the incorporation of these foods into the diets of more recent generations.

Theme 4: Plant foods are important because kids in the household enjoy them

The final theme developed from FP responses in the high adolescent Hb group was one that linked quotes that described plant-food value in terms of children’s enjoyment of them (see **Table 41**). This theme is thinner than the preceding three themes.

Table 41: Key quotes for Theme 4 – High adolescent Hb group

Theme 4: Plant foods are important because kids in the household enjoy them
“They love it a lot, and I prepare it a lot…” [27]
“When I find that there is a deficiency in their blood – the kids – they don’t like foods made with chicken a lot – [that’s when] I make [these foods].” [71]

Decision-making around plant-food inclusion in household diets was related here to children’s enjoyment of them. One FP tied her children’s love of plant foods to her preparation of them: “They love it a lot, and I prepare it a lot…” (Table 41, [27]). Another FP explained that these are the foods she chooses to prepare when her children are in need of nutrients to remedy deficiencies, as “the kids – they don’t like foods made with chicken a lot” (Table 41, [71]). This speaks to her children’s taste preferences; it suggests that given the choice between plant and

meat foods, they would enjoy consuming the nutrients necessary for their health in plant-food form over an alternative meat form.

In summary, Theme 4 highlights a final dimension along which plant foods are valued by FPs of the high adolescent Hb group; it offers that plant foods are incorporated into household food landscapes because the children in these households enjoy them or, indeed, prefer them to alternative food vehicles carrying nutrients essential for their health.

Themes compared: Low and high adolescent Hb groups

The themes reported in this chapter in their final organisation are summarised in **Table 42**. The final number of themes generated from responses in the low adolescent Hb group was 6, while the final number for the high adolescent Hb group was 4 including 2 subthemes. In comparing themes across these two groups, an answer may be formulated to the research question posed at the beginning of this section: "Are plant foods valued differently by food preparers in households with anaemic compared with non-anaemic adolescents?" Differences in FP group responses on plant-food valuation were sometimes stark (i.e. mutually exclusive themes) and sometimes more subtle (i.e. discrepant perspectives on similar topics).

Table 42: Final themes and subthemes for low and high adolescent Hb groups summarised

Low adolescent Hb group	High adolescent Hb group
Theme 1: Plant foods contribute importantly to optimising general health	Theme 1: Plant foods are an important food category and contribute differently when compared to meat foods Subtheme 1: Plant foods promote blood health Subtheme 2: Plant foods are good for digestion
Theme 2: Predominance of taste preferences when valuing plant foods	Theme 2: Plant foods contain essential nutrients
Theme 3: Plant foods contain essential nutrients	Theme 3: There are generational differences in the way plant foods are valued
Theme 4: Home-cooking, the category into which plant foods fall, is preferable to take-out foods	Theme 4: Plant foods are important because kids in the household enjoy them
Theme 5: Plant foods are not complicated to prepare	
Theme 6: Food insecurity impacts choice to prepare plant foods	

Clearer differences between the two groups comprised responses that produced mutually exclusive themes. For example, the low adolescent Hb group highlighted additional reasons for valuing plant foods that were not brought up by respondents in the high adolescent Hb group, i.e. the comparative ease with which plant foods could be prepared and the reduced expense associated with their preparation. Additional points of context within which the interview question and subsequent discussion were placed were also different between the two groups. Plant foods were aligned with home-cooking in the low adolescent Hb group, for example, and benefits (health and other, e.g. food safety) associated with the latter were implicitly extended to the former. In the high adolescent Hb group, however, barriers to including plant foods in diets across generations that valued them differently were discussed.

More subtle differences were also present across group responses that touched on similar topics. Broadly, the two groups shared the perception that plant foods constituted a distinct category of foods that contributed importantly to optimising general health. Both groups situated plant foods in relation to meat foods to explain their importance. They also shared rationales that plant foods were important because of their essential nutrient contents, and that plant foods were valued for their taste.

Although these perceptions were similar across the two groups, their importance was explained with different degrees of specificity in each, and different shades of meaning were interpreted from them. Responses in the low adolescent Hb group remained general, and health and nutrition were cited as being associated with these foods with limited extension of these rationales to specific health outcomes. This contrasted with the specificity provided in responses from the high adolescent Hb group. While health and nutrition were also spoken of generally in this group too, the specific health outcomes of improved blood and digestive health were additionally cited in responses from the high adolescent Hb group.

Discussions of essential nutrients in the two groups also differed, though this theme was generated for both groups independently. The theme was thicker in the high adolescent Hb group and, again, responses contained more specificity. In the low adolescent Hb group, respondents mentioned iron and vitamins, as was done in the high adolescent Hb group, but only one respondent extended this further to suggest that the presence of these nutrients was important because they were essential for a child's health. The theme was thicker in the high adolescent Hb group. Further, respondents in this group routinely linked plant foods with specific nutrients (again, iron and vitamins) and then extended that link to tie nutrient content to health outcomes

(e.g. ‘mallow contains iron, which is associated with blood health’). The health outcomes linked to essential nutrients contained in specific plant foods included increased diet diversity to “complete” a diet, blood health and child growth and development.

Finally, taste was described across both groups as being an important consideration in decision-making surrounding plant-food preparation in households. The theme was thicker in the low adolescent Hb group. The viewpoint on this shared topic was different in each group, too. In the low adolescent Hb group, respondents described taste as being the factor that overrode health and nutrition considerations; while in the high adolescent Hb group, taste was described as allowing for the implementation of a multifaceted approach to maintaining health (i.e. through combating nutrient deficiencies).

FP responses in the low and high adolescent Hb groups offered a range of insights into the valuation of plant foods in participating households from the Beddawi refugee camp community. While there was cross-over between the groups in terms of the themes produced from these responses, original themes were generated in each group, as were original insights within and across groups where similar themes were produced.

CHAPTER EIGHT: DISCUSSION

The findings reported in the quantitative and qualitative results chapters are interpreted in this chapter with reference to the set of questions posed in order to capture different aspects of this study's overarching research question. Anaemia prevalence is discussed ahead of adolescent diet diversification and household plant-food use. The contributions of this study are described in each section, and a summary of the response each section provides to the overarching research question is given at the close of each section.

Adolescent anaemia prevalence at the Beddawi refugee camp

To the knowledge of its author, this research offers the first anaemia prevalence data for a group of adolescent Palestinian refugees resident at the Beddawi refugee camp in North Lebanon, albeit for a small sample thereof. Prior to this study at the Beddawi camp, available data on Hb concentration and anaemia prevalence for Palestinian refugees in Lebanon came from two previous nutrition surveys conducted in refugee camps across North Lebanon. The first of these surveys was conducted in 1961 and provides Hb concentration data for a total of 41 adolescent Palestinian refugees (n[female] = 17, n[male] = 24) across camps in the region (not including the Beddawi camp) (USICNND, 1962). The survey reported anaemia prevalence of 25% for males aged 10-14 y, 50% for females in the same age range, and 42.8% for females aged ≥ 15 y USICNND, 1962). Anaemia prevalence could not be ascertained for males aged ≥ 15 y from reported data. The second of these surveys was conducted in 1990, and assessed anaemia prevalence for 1371 Palestinian refugee children aged 6 mo – 3 y who were resident at camps across the West Bank, Gaza, Jordan, Syria and Lebanon (Hassan et al., 1997). Anaemia prevalence was found to be 70% across all refugee camps in Lebanon for these children, and male children had slightly higher anaemia prevalence than females (72% compared to 68%) (Hassan et al., 1997).

One aim of this study was to produce data on anaemia status for an adolescent Palestinian refugee group from a long-term Lebanese camp. To this end, the following research question was posed: "What is the anaemia prevalence for a group of Palestinian adolescent refugees living long-term at the Beddawi camp?" Adolescent anaemia prevalence at the Beddawi camp was expected to fall into either the moderate or severe WHO 2011 categories of public health significance (i.e. moderate: 20.0-39.9%, severe: ≥ 40%), given available estimates for adolescent anaemia prevalence across other long-term refugee camps. Estimated anaemia prevalence in these camps ranged from 10 through to 54%, with prevalence exceeding 20% for the majority of reports (Abudayya et al., 2007; Engidaw et al., 2018; Khatib et al., 2010; Woodruff et al., 2006).

In this study, overall anaemia prevalence was found to be 29% for participating adolescent Palestinian refugees resident at the Beddawi camp. This classes the situation as a 'moderate' public health concern as per WHO 2011 criteria. This anaemia prevalence estimate falls within the range of prevalence estimates reported for adolescents resident at other long-term refugee camps across Africa and Asia. Anaemia prevalence at the Beddawi camp was considerably higher than recent anaemia prevalence reports for Palestinian children and young adolescents (aged 5-15 y) at central Lebanese camps participating in a nutrition intervention (Jamaluddine et al., 2020). Anaemia prevalence at baseline for each the control and intervention groups in the study were 9.95% and 12.36%, respectively, and mean Hb concentration for each was 127.9 (0.42) and 124.5 (0.38) (Jamaluddine et al., 2020). The lower anaemia prevalence in the 2020 study compared to the prevalence reported at the Beddawi camp may be explained by the discrepant anaemia cut-offs assigned in each study. Jamaluddine *et al.* (2020) used a Hb cut-off of < 115 g/L to assign anaemia for all participants, while a cut-off of < 120 g/L was used to assign anaemia for young adolescents at the Beddawi camp. As such, Jamaluddine *et al.* (2020) likely captured more severe anaemia only for the young adolescent participants in using this cut-off, which would result in a reduced anaemia prevalence for the group overall, while the Beddawi study captured any level of anaemia and so would produce a higher prevalence estimate.

Anaemia prevalence was not found to be significantly different for females (33.3%) and males (22.7%) in the sample from the Beddawi camp. This finding of similar prevalence for female and male adolescents is consistent with prevalence findings for adolescents at the Kakuma camp in Kenya and the Khazana camp in Pakistan, which also found no difference in anaemia prevalence between female and male adolescents (Saeedullah et al., 2021; Woodruff et al., 2006). These contrast with the majority of reports on adolescent anaemia prevalence by sex across refugee camps in Africa and Asia, wherein anaemia risk has been found to be significantly higher for females than for males (Woodruff et al., 2006).

While anaemia prevalence was not different for sex groups at the Beddawi camp, mean Hb concentration was found to be significantly higher for male compared to female adolescents in the overall sample and within the pubertal adolescent group. Mean Hb concentration was not found to be different for the whole female sample (aged 10-19 y) compared to the younger male group (aged < 15 y). Anaemia prevalence for pre-pubertal adolescents was 16.7% and 29.8% for pubertal adolescents, while mean Hb concentration was not significantly different between the two groups. Proportion comparisons by pubertal group could not be performed to determine

significance of differences observed at the Beddawi camp because of sample size limitations. Higher prevalence for pubertal adolescents at the camp would be consistent, however, with the majority of studies across other camps in the region (i.e. Kenyan, Nepalese, Jordanian and Ethiopian camps), which reported higher anaemia prevalence for pubertal compared to pre-pubertal adolescents (Engidaw et al., 2018; Khatib et al., 2010; Woodruff et al., 2006).

Puberty onset marks a period of higher iron need for both females and males to match blood volume increases that accompany growth increases (Mesías et al., 2013). Male adolescents also experience increased erythropoiesis alongside the increased testosterone levels associated with their growth during puberty (Bergström et al., 1995; Mesías et al., 2013), which may explain the higher mean Hb concentration for pubertal males compared to pubertal females observed at the Beddawi camp. This may also explain the significantly higher mean Hb concentration for males ≥ 15 y compared to males < 15 y, and the comparable anaemia prevalence between the younger male adolescent group and the whole female group in the sample from the Beddawi camp. While female adolescents may be at higher risk of anaemia development due to a combination of increased growth demands and the additional need to recover menstrual losses, young adolescent males, with their analogous increased growth demands, may experience exacerbated risk under conditions where population-level food access and socioeconomic opportunities are constrained, as is the case at the Beddawi refugee camp.

Section contribution to answering overarching research question

Data on anaemia prevalence for Palestinian adolescent refugees at the Beddawi camp in North Lebanon provide context into which the remainder of collected data on associated dietary factors may be interpreted. Anaemia prevalence of 29% for participating adolescents overall indicates that anaemia is a moderate public health problem within this sample.

Adolescent diet diversity and dark leafy green use at the Beddawi refugee camp

Adolescent diet diversity

This study contributes the first diet diversity data for adolescents at the Beddawi camp in North Lebanon. Two research questions were posed in order to describe diets of adolescents at the camp. The first sought to explore overall diet diversity for this group: “How diverse are the diets of these adolescents?” The second question sought to describe consumption of food-group contributors of haem and non-haem iron, respectively, to the diets of these adolescents: “To what degree are plant foods consumed by these adolescents compared with meat foods?”

The median diet diversity score determined for the sample of adolescent Palestinian refugees resident at the Beddawi camp was 4 [IQR = 1.63, range = 2-6]. No significant differences were observed for diet diversity scores between females and males, nor were they observed for recall groups. Food group consumption was assessed for a total number of 10 possible food groups. For this sample, a diet diversity score ≤ 3 was considered low, a score between 3 and 4 (inclusive) was considered moderate, and a score > 4 was considered high. Proportions of females and males falling into each of these groups were also not significantly different (χ^2 = 3.68, df = 2, p-value = 0.16). Given this, the majority of participants had scores that assigned them moderate diet diversity within the study population; however, a median of 4 of 10 possible food groups suggests that diet diversity is compromised in this population as less than half of all possible food groups were consumed by most participating adolescents. The 10 food groups were intended to capture the micronutrient diversity of diets, in particular. As such, the compromised diet diversity outcomes suggest, consequently, that dietary micronutrient adequacy is also compromised in this group.

In a recent dietary assessment conducted at central Lebanese camps for Palestinian children and young adolescents, mean diet diversity in each the control and intervention groups at baseline was 4.35 (0.05) and 4.17 (0.05), respectively, of 8 possible food groups (Jamaluddine et al., 2020). These outcomes indicate comparatively more diverse diets at these camps than diet diversity outcomes from the Beddawi camp, in that, on average, at least half of all food groups were consumed by children and adolescents in the study pre-intervention, which was not the case at the Beddawi camp. Diet diversity findings from another recent dietary intervention conducted across low socioeconomic areas of central Lebanon, this time for low-income Lebanese and Syrian refugee children and adolescents (aged 8-16 y) (Jamaluddine et al., 2022), were more comparable to the Beddawi camp outcomes. Lebanese and Syrian groups in the control arm of this study were found to have diet diversity scores of 4.57 (0.10) and 4.47 (0.08), respectively, of 11 food groups (Jamaluddine et al., 2022). Similarly, Abou-Rizk *et al.* (2021) recently reported a diet diversity score of 4.04 (1.30) of 10 possible food groups for non-pregnant non-lactating Syrian refugee women also resident in low socioeconomic areas of central Lebanon (Abou-Rizk et al., 2021).

No correlation was found between adolescent diet diversity score and adolescent Hb concentration (rho = 0.23; S = 37110, p-value = 0.07) for the Beddawi camp sample. Hb concentration was also not significantly different across the three diet diversity groups (low,

moderate and high) (W = 547.5, p-value = 0.15), nor was anaemia prevalence (χ^2 = 3.10, df = 2, p-value = 0.21). Adolescents at the Beddawi camp reported consumption from each of the 10 food groups included in the diet diversity assessment to different degrees. The *Grains, white roots and tubers, and plantains* food group was consumed by all adolescents; this group had the highest proportion of consumers. The *Milk and milk products* and *Other fruits* food groups had the second and third highest proportions of consumers, respectively. *Other vitamin-A rich fruits and vegetables* was the food group with the fewest consumers, followed by *Nuts and seeds* and *Dark green leafy vegetables*. Food groups containing significant haem and non-haem iron source food contributors were: *Meat, poultry and fish*, and *pulses*, *nuts and seeds* and *dark green leafy vegetables*, respectively. Over half of all adolescent participants (56.1%) consumed haem-sources of iron, as per a single 24-hr recall, while 43.9% of adolescent participants consumed non-haem iron sources outside of the *Grains, white roots and tubers, and plantains* food group. Mean Hb concentration was not significantly different for adolescents consuming haem iron sources compared to not at the Beddawi camp (t = 1.78, df = 57.8, p-value = 0.08).

As reported for the Beddawi camp, Abou-Rizk *et al.* (2021) similarly found no association between diet diversity score and Hb concentration for non-pregnant non-lactating Syrian refugee women in low-income areas of central Lebanon. These findings may be explained by the inconsistent relationship observed for haem iron source food consumption and iron deficiency and/or anaemia risk in resource-poor contexts, including at long-term refugee camps. In assessing diet variety and its association with dietary micronutrient adequacy, for example, Foote *et al.* (2004) found that variety in the meat group was not associated with dietary adequacy for individual nutrients that included iron in their study, while this association was observed for variety in the vegetable and grain groups in relation to adequacy of “at-risk” nutrients. Olumakaiye (2013) also found that the proportion of adolescent girls who were iron deficient was not significantly different compared to girls who were iron replete based on meat consumption in her study. In this study, however, meat was distinguished from fish, and fish consumption was found to be higher for the iron replete group compared to the iron deficient group (Olumakaiye, 2013). This study also found increased consumption of non-haem iron source foods in the form of dark leafy greens and legumes for iron replete compared to iron deficient groups (Olumakaiye, 2013). For consumers of each haem and non-haem iron food sources, the proportions of adolescent girls in the iron deficient and iron sufficient groups were also significantly different (Olumakaiye, 2013), suggesting that both iron sources contributed importantly to biochemical iron adequacy.

The impact of haem iron food sources on biochemical iron status is likely tied to the frequency of its consumption, as has been explored by Engidaw *et al.* (2018) for adolescent girls at a long-term refugee camp in Ethiopia. In the study, haem and non-haem iron source food consumption was examined in relation to anaemia risk. Consumption of haem iron at least twice per week was found to be associated with a drastically reduced anaemia risk when compared to its consumption less than once per month (Engidaw et al., 2018). This study also found that anaemia risk was decreased with consumption of eggs, a non-haem iron contributor, at least twice per week, again compared to consumption less than once per month, though the risk reduction was much larger with regular haem iron consumption compared to non-haem iron consumption (Engidaw et al., 2018). While haem iron source foods contribute the most bioavailable form of iron and, as such, would be expected to be associated with biochemical iron status, this relationship has not been reliably observed in resource-poor contexts, including in this study at the Beddawi camp. Haem iron food source consumption that is not regular enough to impact biochemical iron status significantly may be one reason that no Hb concentration differences were observed for adolescents reporting meat consumption in the 24 hours preceding food recalls compared to those who did not. Reliance on plant source foods (i.e. grain-based foods) to meet the majority of dietary needs in the context of the observed compromised diet diversity may offer an additional explanation for the lack of association between haem iron consumption and biochemical iron status at the Beddawi camp, despite the former iron form's favourable bioavailability.

Household dark leafy green and edible wild plant use

In order to interrogate the potential for diversifying diets through available foods rich in diverse micronutrients, this study also sought to respond to the following research question: "Do dark leafy greens – a food group that is part of the traditional food landscape of this community and also an important dietary source of non-haem iron – offer an avenue through which diets may be further diversified in the households of these adolescents?"

All dark leafy greens included in the study's FFQ were utilised to some degree by households for which data were available. Two cultivated (i.e. spinach and parsley) and two edible wild plants (i.e. jute mallow and chicory) were used by at least 80% of households at least once per month. Dark leafy greens included in the FFQ were also cross-referenced with plant foods independently reported by food preparers in the food preparation section of interviews, and those that were also reported by at least 20% of food preparers in those open-ended interviews were treated as a subset of interest for further analysis. Of the 7 dark leafy greens remaining from the initial 14 on

the FFQ, 5 were edible wild plants. At least 20% of food preparers reported using these 7 plants in their open recalls, and the proportions of households reporting their use in the FFQ ranged from 61.8-92.7%. The contribution that these plant foods can make to dietary micronutrient adequacy for adolescents in these households is reflected in their high mineral content. Batal and Hunter (2007) have demonstrated that the iron contents of a selection of edible wild plants collected in Lebanon, for example, ranged from 3.17-18.2 mg/100g, with the exception of a single plant – wild thyme (Batal & Hunter, 2007). Several of these plants were included in the FFQ administered at the Beddawi camp; these were fennel, chicory, gundelia, mint and mallow. Further, chicory, for example, the wild plant utilised by the second largest proportion of households, was found to have the second-most substantial iron content (10 mg/100g) of all the wild plants analysed by Batal and Hunter (2007).

Increased utilisation of edible wild plants has been shown to be associated with increased diversity of fruit and vegetable consumption in rural Lebanese communities (Al-Masri, 2017). Wild plants examined in this study included several of the wild plants also included in the FFQ administered to food preparers from the Beddawi refugee camp; these were chicory, mallow, purslane, wild thyme, gundelia and wood sorrel. The vegetables examined by Al-Masri (2017) also included several of the dark leafy greens on the Beddawi camp FFQ, including spinach, parsley and mint. Al-Masri (2017) examined the harvest frequency of edible wild and domestically produced plant foods across three rural Lebanese settings, and found that wild plant harvesting at different intensities over a year-long period (i.e. none: 0, moderate: 1-4 times and high: ≥ 5 times) was associated with increased variety of consumption of fruits, vegetables, and a combined fruit and vegetable food group. Harvest intensity of domestic plant foods was also found to be associated with variety of consumption from the vegetable, combined fruit and vegetable group, as well as for the fruit only group (Al-Masri, 2017). Wild plant and domestic harvest intensity was also examined against frequency of consumption from these food groups. Al-Masri (2017) found that decreased mean consumption from the vegetable and combined fruit and vegetable groups was found for ‘no’ and ‘moderate’ compared to ‘high’ wild plant harvest intensity, while mean consumption from all three food groups was significantly increased as domestic harvest intensity increased. Harvesting of wild plants was also found to be positively associated with domestic plant harvesting, suggesting increased household-level production of plant foods with increased use of wild plants (Al-Masri, 2017).

At the Beddawi camp, household use of dark leafy greens and edible wild plants were each examined against adolescent DDS-M outcomes. Household use of a subset of dark leafy greens listed on the FFQ that were also commonly reported in plant food preparation open recalls was found to be positively correlated with adolescent DDS-M (rho = 0.31, S = 14303, p-value = 0.03), while edible plant use and dark leafy green use with respect to the full set of plants were not. This may suggest that increased use of dark leafy greens by Palestinian households at the camp could contribute meaningfully to adolescent diet diversification, depending on the selection of dark leafy greens available for use.

Refugees, particularly in camp contexts, meet with restrictions to their use of land in host countries and to their access to space for home gardening, which can limit their ability to harvest from wild plots and to produce plants domestically (Kahara et al., 2021; Manduzai et al., 2021; Talhouk et al., 2021). The impacts of relocation on the use of these plants, which are often tied to the traditional food and medicine systems of these communities, result in a discrepancy between community knowledge of these plant foods and their actual use, which is mediated by access to plots of land for foraging, water availability, soil quality and/or market availability of previously utilised plants in the new host country (Kahara et al., 2021; Manduzai et al., 2021). Access to land, which is more available to refugees residing outside of camps, has been shown to contribute to the continuation of foraging and planting practices, which, in turn, contributes to the retention of knowledge surrounding these practices and, so, to their continued implementation (Kahara et al., 2021; Manduzai et al., 2021). However, while use of these plants, especially edible wild plants, is reduced in these communities, the practice is retained where access is possible, and harvesting of these plants has been shown to provide a buffer against nutritional vulnerability for food-insecure households that continue to engage in their use (Kahara et al., 2021; Manduzai et al., 2021). Vertical gardening strategies have also recently been demonstrated to comprise an alternative route for accessing dark leafy greens and edible wild plants for camp-resident refugees (Talhouk et al., 2021).

Increased dark leafy green use, including of edible wild plants, may comprise a feasible food-based avenue through which adolescent diets might be further diversified at the Beddawi camp. Access to these plants at the camp, however, is likely more viable through purchase from vegetable vendors and/or independent gatherers therein, as land access and home gardening space are limited. Community gardening practices that incorporate vertical gardening strategies

might also be an avenue through which these plant foods might be incorporated to a greater degree in adolescent diets at the camp.

Food preparer valuation of plant foods

The perspectives of household food preparers on the value of plant foods necessarily impact the degree to which these foods are included in an adolescent's diet, which in turn has relevance for interpreting plant food use data and the viability of recommending this diet diversification route within this community for improving iron status. As such, this study sought to describe food preparer perceptions of the value of plant foods. To achieve this, the following research question was posed: "Are plant foods valued differently by food preparers in households with anaemic compared with non-anaemic adolescents?" A variety of responses were offered across the two groups, and these responses offer a starting point from which further investigation of the themes generated from these rationales, which inform whether plant foods are included or excluded in household diets, may be undertaken. These findings additionally provide preliminary insights into rationales that may resonate with food preparers in the camp, which can aid in the development and promotion of strategies for increasing diet diversity (e.g. through increased dark leafy green use) for adolescents therein that are acceptable, practicable and sustainable to those responsible for a household's food preparation.

A key rationale shared across the two groups was the valuation of plant foods for their health and nutritive contributions, which were placed alongside the meat food group to highlight their dietary significance. Both groups also reported valuing these foods for their taste. Food preparers in households with anaemic adolescents described plant foods as comprising cost-effective, uncomplicated, and safe food preparation options. These additional dimensions did not arise in food preparer responses from the non-anaemic adolescent group. Food preparers from households with non-anaemic adolescents focused primarily on plant food contributions to health promotion. In discussing these attributes, food preparers in this group explicitly linked plant foods to nutrients and positive health outcomes. While food preparers in both groups discussed plant-food valuation with reference to health promotion, responses contributing to the development of this theme in the non-anaemic adolescent group were more detailed and numerous. While the sample from the Beddawi camp was small and so these findings must be interpreted with caution, these outcomes may be indicative of differences in food preparer nutrition knowledge across the two groups, including for anaemia, its relationship to iron status, the iron and vitamin contents of plant food sources and principles of iron absorption enhancement.

Knowledge of anaemia has been shown to be linked with increased use of iron-rich foods, including plant food sources of iron (Agbemafle et al., 2019; Metwally et al., 2020), which may suggest intentional incorporation of this nutrition knowledge into choices surrounding a food's use or preparation. The application of such knowledge has the capacity to impact iron status for members of households wherein food preparers are aware of anaemia, its association with iron deficiency and where there is knowledge of iron-rich foods and their preparation. Nutrition knowledge has been demonstrated to be associated with the anaemia status of food preparers and their children (Kikafunda et al., 2009; Zhang et al., 2018). In a study conducted by Kikafunda *et al.* (2009) that explored, among other factors, the relationship between food and nutrition knowledge of mothers (i.e. household food preparers in this context) and child anaemia status, knowledge about diversifying children's foods through preparation of multi-food mixtures was found to be associated with their lowered anaemia risk (Kikafunda et al., 2009). Further, in a nutrition education intervention conducted with mothers of anaemic children aged 2-12 y in Egypt, significantly improved iron status in the children was found to occur concurrent to nutrition knowledge increases in their mothers (Metwally et al., 2020). Mothers were educated on anaemia, the impacts of anaemia on child health, iron-rich food sources, and strategies for maximising the bioavailability of iron contained therein (Metwally et al., 2020). Maternal outcomes on a questionnaire assessing nutrition knowledge on these topics were found to be significantly improved post-intervention, and anaemia prevalence in the children was also significantly reduced (40% from 100%) (Metwally et al., 2020). The frequency of consumption of both haem and non-haem iron food sources was also found to have increased significantly for children post-intervention, as were their Hb outcomes (Metwally et al., 2020). These studies demonstrate that maternal knowledge of iron-linked health and nutrition principles can positively impact Hb and anaemia status in their children. They also demonstrate that knowledge of iron-rich food sources and the impact of dietary enhancers and inhibitors on non-haem iron absorption can also have positive implications for children's iron status.

Section contribution to answering overarching research question

The median diet diversity for the sample of adolescents assessed in this study was 4 of 10 possible food groups, suggesting that dietary micronutrient adequacy is compromised in this population to some degree. Further, although meat was consumed by over half of participants in the 24-hr period preceding food recall interviews, Hb concentration was not significantly different for meat consumers compared to non-consumers. This may suggest that, while meat is consumed by adolescents at the Beddawi camp, it is potentially not consumed to the degree required to impact Hb concentration significantly. While this may be due to the small sample size

from which these data are drawn, it is also plausible that this is, in part, related to a routine reliance of the sample population on non-haem food sources of iron to meet daily needs and the low bioavailability of this form of iron in the absence of food-based strategies to mitigate this.

In view of the reduced diet diversity of this group combined with reliance on plant-based foods, diet diversification through increased use of easily accessible dark leafy greens may be an appropriate strategy for this group. Dark leafy greens were not consumed by a large proportion of adolescents, as per their 24-hr recall interviews. However, food preparers in households with both anaemic and non-anaemic adolescents reported positive valuation of dark leafy greens in their responses about broader plant-food value. While a range of descriptions were given by FPs for this valuation of plant foods, health and nutrition benefits were identified, across the board, as being within the purview of plant food action and spoke to the food group's value. The comparatively thicker theme developed around this point of valuation from FP responses in the non-anaemic compared to the anaemic adolescent group may speak to the nutritionally protective value of food preparers possessing more detailed nutritional knowledge. These findings suggest a role for dark leafy greens in diversifying diets of adolescents in this population through increased home preparation. This would be appropriate if access to these plant foods could be ensured (e.g. through local vegetable vendors and independent gatherers). This section further offers that increasing iron-specific health, food and nutrition knowledge for food preparers at the camp might further contribute to improved adolescent iron outcomes.

Household plant food use at the Beddawi refugee camp

In order to begin to address the bioavailability dimension of optimising adolescent iron status through diet diversification in the context of non-haem source food dependence, this study further sought to identify the plant foods prepared in households at the camp. Plant-food preparation details were sought from food preparers, in order to explore the scope for impacting non-haem iron bioavailability at the household level. Two research questions were posed to achieve this: "What plant foods are prepared in adolescent households at the camp?" and "How are plant-food contributors of non-haem iron usually prepared and consumed in these households?"

This study contributes the first detailed plant-meal reference list produced directly from individual food preparers at any refugee camp in Lebanon. While plant food reference lists have been produced from interviews with residents of rural Lebanese communities (Batal & Hunter, 2007), the plant foods reported on in this thesis further comprise the most comprehensive list of plant foods in use by a single community in Lebanon to date. This list is also the first prepared for a

Palestinian community residing at a long-term refugee camp in Lebanon. In combination with the food preparation data collected for reported meals, these data offer insights into specific food components and preparation techniques that have the capacity to influence the bioavailability of non-haem iron present in these meals. As such, they comprise dietary reference material of specific relevance to evaluating non-haem iron bioavailability for this community.

Food preparation interviews revealed that a number of preparation techniques that could impact non-haem iron bioavailability were already utilised at the camp. Lemon juice was a common addition to prepared plant foods, especially for meals with edible wild plants at their centre. Fresh vegetables also high in vitamin C (e.g. raw chilli, capsicum, radish and green onion) were also often reported as being served alongside meals. Salads that included tomato and lemon juice, and/or dark leafy greens were also reported as being consumed alongside these meals (e.g. with mujaddara dishes). The regular reporting of these practices by the food preparers interviewed suggests that consumption of vitamin C along with non-haem iron meals is likely to be acceptable in households at the camp, where these raw ingredients are available and where there is sufficient income for their regular purchase. Meat was another non-haem iron absorption enhancer that was reported to be included in some of these plant-based meals (e.g. the mulūkhiya and fāṣūliyā meals). Food preparers also described including stock cubes in these meals as substitutes for meat, however, which may speak to a routine compensatory response to food insecurity and a related inability to afford meat to incorporate into these meals regularly. Despite this, meat is a non-haem iron absorption enhancing meal ingredient that would likely be accepted for increased consumption in this community, where its availability could be ensured.

Practices that reduce the inhibitor content of meal ingredients were also described (e.g. the soaking and boiling of beans with decanting steps), which suggests that non-haem iron inhibitor reduction practices are also already present within the community. As such, there may be scope for their intensified inclusion in food preparation at the camp, for example, in extending this practice to application in preparing meals like mujaddara. Food preparers rarely reported using this strategy for mujaddara, which contains phytate from either rice or crushed wheat in combination with lentils. Pre-soaking of any of these high-phytate ingredients was not a commonly reported practice. As salads were often reported as being served alongside these meals, which would already contribute to reducing the impact of any phytic acid present, additional incorporation of these phytic acid reduction processing practices could further enhance the non-haem iron bioavailability of these meals.

Doumani *et al.* (2020) have examined the interplay of various preparation practices applied to ḥummus, a plant-based dip commonly consumed in Lebanese and Palestinian communities, to interrogate the impact of these practices on the non-haem iron bioavailability of plant-based foods in Lebanon. Ḥummus is a chickpea dip had at breakfast and alongside barbequed meats, and is often consumed with flatbread. The usual ingredients included in ḥummus are chickpeas, tahini, lemon juice and garlic. Doumani *et al.* (2020) examined 8 different ḥummus preparation styles and assessed non-haem iron bioavailability using an *in vitro* digestion model. The preparation styles varied in terms of pre-preparation practices applied to the chickpeas (e.g. soaking, boiling, germinating) and in terms of various combinations of the remaining ingredients (Doumani et al., 2020). Formulations that excluded tahini were found to have the highest non-haem iron bioavailability, while those that included lemon juice in its absence were found to have the highest, illustrating the significant influence these food components exert on non-haem iron bioavailability in this meal (Doumani et al., 2020). Of the processes or ingredients that significantly impacted non-haem iron bioavailability in this study, lemon juice was found to have the largest impact (Doumani et al., 2020). An overall increase in non-haem iron bioavailability was still observed, however, in preparations that incorporated both tahini and lemon juice, despite tahini's inhibitory effect (Doumani et al., 2020). Autoclaving was a chickpea pre-processing technique associated with increased non-haem iron bioavailability in the dip, while boiling was not found to achieve the same (Doumani et al., 2020). These findings demonstrate that interventions targeting food preparation practices that influence non-haem iron bioavailability at the household level may have significant impacts on the biochemical iron status of household members.

Doumani *et a.* (2021) subsequently explored knowledge of non-haem iron bioavailability considerations with respect to ḥummus preparation for a sample of Lebanese women. Pre-soaking of chickpeas, pressure cooker preparation of chickpeas (the household analogue of autoclaving), and increased lemon juice with decreased tahini inclusion were considered to be enhancers of non-haem iron bioavailability in the ḥummus preparation styles examined (Doumani et al., 2021). The study found that while most women who prepared ḥummus were soaking (with decanting) chickpeas ahead of their incorporation into the dip (where pre-prepared canned chickpeas were not used), only small proportions of these women (i.e. less than a fifth) were utilising a combination of practices associated with increased non-haem iron bioavailability (Doumani et al., 2021).

The regular reporting by food preparers at the Beddawi camp of lemon juice additions to plant-based meals, co-consumption of vegetables high in vitamin C and pre-soaking and decanting

practices for pulses, together with the above findings from the literature suggest that a combination of these practices may be appropriate to recommend for intensification at the camp in order to optimise adolescent dietary iron bioavailability and, potentially, biochemical iron status.

Section contribution to answering overarching research question

The plant foods prepared in adolescent households at the Beddawi camp are many and varied, and they are prepared using a range of methods that likely impact non-haem iron bioavailability to different degrees. Many of the reported plant foods contain non-haem iron in amounts that could impact adolescent iron status positively, if the bioavailability of this iron is ensured. These food lists also illustrate that a range of non-haem iron absorption enhancing ingredients are included in meals or are consumed along with these meals. These findings comprise an important opportunity for non-haem iron bioavailability optimisation at the household level. Intensified co-consumption of vegetables high in vitamin C with plant-based meals combined with the extension of pre-soaking practices to lentils and rice may have the capacity to improve the bioavailability of non-haem iron in the plant-based meals commonly prepared at the Beddawi camp. These are also strategies that are likely to be acceptable in this community as they are already present within it to some degree.

CHAPTER NINE: CONCLUSION

This chapter begins with a reflection on the study's limitations. Potential extensions to the study are described next, followed by policy implications and recommendations in line with its key findings. The chapter closes with a final summary of the study's findings.

Study limitations

This study comprises a preliminary research point from which additional work may be conducted to further address key questions it raises and to follow up on its key outcomes. In order to build upon it, the study's limitations must be considered; they are outlined below.

Sample size

A major limitation of this study is its small sample size, which prevented more detailed analyses on adolescent Hb and anaemia status within sex, age and pubertal groups from being performed. The small sample size also prevents the findings described for the participating adolescent group from being generalisable. A larger sample size – estimated using a higher precision value and narrower CI boundaries (i.e. d = 0.05, CI = 95% and Z = 1.96) – would allow for the production of representative variable estimates. It would also allow for a more comprehensive exploration of food preparer perspectives on plant-food value, which would have made the development of further insight into the themes produced from this small group possible.

Sampling method

The next major limitation of this study's design is its sampling method. While convenience and snowball sampling became necessary under the prevailing research conditions, systematic random sampling of adolescents across UNRWA schools within the Beddawi refugee camp would comprise the most appropriate method for producing representative estimates for the variables examined in this research.

Interview instrument validation

An additional limitation of this study's methods lies in its use of the interview instrument within the Beddawi camp refugee community without prior piloting. This was due, again, to time and logistics constraints. Piloting of this instrument with a small number of adolescent-FP pairs and amending questions with reference to cognitive interview discussion findings would enhance the instrument's validity within the cultural and linguistic context into which it was being deployed.

Food security assessment

The food security assessment conducted in this study was brief and broad, which limited the degree to which food security status could be evaluated for participating households. While

questions in this section of the instrument were posed to capture two major aspects of food security as defined by consensus at the 1996 UN World Food Summit, and while they were reviewed by members of the research team ahead of instrument finalisation, use of a food security assessment tool validated for this community would describe participant food security status more appropriately. In future, such an assessment may be administered directly to participating adolescents using the 10-item food insecurity scale recently validated for use with Palestinian children and young adolescents (aged 5-15 y) across UNRWA schools in Lebanese camps (Jamaluddine et al., 2019). Alternatively, and in lieu of validation of this instrument for adolescents aged ≥ 15 y, a food security assessment using the Arabic version of the Household Food Insecurity Access Scale, which has been validated for use in rural Lebanese populations, would ensure a more thorough and culturally-appropriate evaluation of food security status in this population (Naja et al., 2015).

Retrospective application of positive deviance methodology

A key limitation of this study's qualitative methods relates to the retrospective application of positive deviance methodology during the data analysis phase of the research; this methodology was not integrated into the design phase of the study to guide qualitative data collection. As such, the data produced in this way could only contribute general and possibly confounded insights into the relationship between food preparer valuation of plant foods and adolescent anaemia status. Qualitative data collection guided explicitly by positive deviance methodology would have allowed for more insightful exploration and interpretation of differences in food preparer perspectives on plant-food use for households with anaemic compared to non-anaemic adolescents, as additional perspectives on the iron content, bioavailability and health impacts of plant foods could have been ascertained.

Haem iron source foods

Finally, this research took non-haem iron source foods as its central focus with respect to dietary iron optimisation and anaemia prevention, assuming low haem iron source food use in this population. The dietary findings for adolescent Palestinians at the Beddawi camp illustrate, however, that haem iron source foods were consumed by over half of participating adolescents. Further, the consistent invocation of meat foods as an important food group by food preparers in their explanations of plant-food value suggest a more significant role of this food group in households at the camp than was initially expected. As such, inclusion of an analogous household haem iron source food preparation and valuation component in a future interview

instrument would allow for a more complete evaluation of all key iron source foods (i.e. non-haem and haem) relevant to iron status optimisation and anaemia mitigation in this community.

Potential extensions to the study

Food frequency assessment for haem and non-haem iron food sources reported

An important extension to this study would involve a more detailed characterisation of the relative contributions of haem compared to non-haem iron source foods to adolescent diets at the camp. This could be achieved through the administration of a food frequency questionnaire designed to capture the degree to which these food sources were consumed by adolescents over several months.

Systematised bioavailability assessment using the food reference list from this study

The plant-food reference list produced in this study comprises data that may be used to explore food preparation and consumption practices in the camp further, with reference to iron bioavailability. This could be achieved, for example, through the assessment of Hb and anaemia status for adolescents with reference to the discrepant use of practices identified as potential modulators of non-haem iron bioavailability for individual meals. Further characterisation of the frequency at which meals included on this list are prepared by food preparers could also contribute meaningfully to identifying target meals for intervention. This may be achieved through the development and administration of a questionnaire that characterises the frequency of preparation of individual meals over several months and in different seasons.

Food preparer valuation of haem iron food sources

Another extension that might be made to explore iron source food valuation further at the camp could include a meat source food preparation and valuation component that complements the plant source food evaluations undertaken in this study. Comparisons between food preparer valuation of haem compared to non-haem iron source foods would allow for further contextualisation of findings on plant-food valuation.

Plant food accessibility evaluation

A final important extension to this study would be to evaluate the accessibility of plant foods identified in this study as having the capacity to influence iron adequacy either through contributing to the diversification of diets or to increasing the bioavailability of non-haem iron in available foods. The degree to which dark leafy greens with appreciable iron contents are accessible at the camp (e.g. through vendors or independent gatherers), as well as the availability

of key vitamin C contributors (i.e. lemon, tomato, chilli, capsicum, radish and green onion) must be evaluated before their increased consumption can be viably recommended. This extension would also need to include a component evaluating the economic feasibility of increasing consumption of these foods.

Policy implications and recommendations

The vulnerabilities of adolescent Palestinian refugees in Lebanon given the protracted nature of Palestinian economic hardship and social exclusion in this host country cannot be overstated. Conditions for this group are now further exacerbated in the context of the current catastrophic economic crisis unfolding in Lebanon, which has been developing also alongside the unrelenting impacts of the COVID-19 pandemic. Poverty prevalence for Palestinian refugees in Lebanon has most recently been reported to be at least 86% (UNRWA, 2022).

This research took as its focus anaemia and its mitigation through accessible food-based iron optimisation strategies with a view to providing a starting point from which this problem might be characterised for adolescents at a long-term refugee camp for Palestinians in Lebanon. The high poverty rates experienced by this group, which expose adolescents to increased anaemia risk, demonstrate that regular nutritional vulnerability assessments are appropriate for this group. Given this backdrop, and while acknowledging the generalisability limitations of this study, a need for follow-up investigation of the anaemia status of adolescent girls and boys at long-term camps hosting Palestinian refugees across Lebanon is warranted.

Policy implication 1

At present, routine assessment of anaemia status is conducted through the UNRWA for children aged 12 mo upon registration with the organisation. These assessments are conducted across all UNRWA field sites including Lebanon. The extension of such assessments to include an adolescent group (e.g. adolescents entering secondary school) would provide a complementary opportunity to screen for anaemia in this vulnerable population. Such a screening program would allow for the collection of representative baseline data for this group, and would enable longer-term monitoring that would lead to characterisation of anaemia risk through to this additional, key developmental period.

Recommendation 1

Build on the existing UNRWA anaemia screening program to monitor anaemia prevalence and risk for Palestinian adolescents at long-term camps by routinely assessing a representative sample of adolescents (e.g. girls and boys beginning secondary school) for anaemia.

Policy implication 2

The central role household food preparers play in adolescent nutrition and health optimisation is another key outcome of this research that has implications for health and nutrition education policy at long-term camps in Lebanon. The routine conduct of education workshops that focus on iron education, both with reference to anaemia risk and iron bioavailability enhancement in the context of high food insecurity, would likely also contribute positively to household-level optimisation of adolescent iron status. While such workshops have been conducted by the UNRWA and other NGOs across Lebanese camps, their implementation is not routine. Provision of bi-annual courses (e.g. in the first and third quarters of a year) that explicitly tackle key concepts of iron health, its presence in foods in different forms and the enhancement of non-haem iron absorption through existing food-based practices with reference to meals commonly prepared in the community would ensure communication of vital strategies for optimising iron status and combating anaemia risk sustainably in these communities. A brief comprehension check pre- and post-workshop implementation in each quarter should also be included to monitor the effectiveness of the program in delivering its core points. Attendance at these workshops by household food preparers should be prioritised where such education resources are limited; however, it may also be appropriate to include short courses on these topics in relevant parts of the secondary school curriculum to empower adolescents to contribute also to household decision-making around food preparation that impacts their iron status.

Recommendation 2

Implement routine bi-annual iron, iron health and iron-related food preparation education workshops within UNRWA camps, targeting household food preparers as a matter of priority, and move to incorporate such education resources into the secondary school curriculum to enable adolescents to access such information directly. Ensure comprehension checks are routinely administered pre- and post-workshop / short course participation to evaluate understanding and retention of concepts, and to evaluate program appropriateness.

Policy implication 3

Household food preparers in this study regularly reported incorporation of non-haem iron absorption enhancement ingredients in the plant source food meals they described in the food preparation section of interviews. The ingredients were included as key elements within meals and/or were co-consumed alongside prepared meals. The existing routine association of these ingredients with meals containing appreciable amounts of non-haem iron comprises a key opportunity for economic intervention to allow households to intensify their use of existing

practices that contribute to enhancing non-haem iron bioavailability in consumed meals. Ensuring improved access to such meal ingredients (e.g. lemon, capsicum, chilli, green onion and tomato) through a subsidisation program may ensure that the economic aspect of enhancing iron status through food-based, household-level methods is addressed.

Recommendation 3

Integrate the subsidisation of a selection of commonly used vitamin C-rich food ingredients identified within this study into the existing UNRWA Social Safety Net Programme in Lebanon to increase economic accessibility to non-haem iron absorption enhancers that have been demonstrated to be in use and preferred in this community and available in this host country.

Closing remarks on policy implications and recommendations

Lebanon is host to an enormous number of refugees for its size; it hosts the largest number of refugees proportional to its population of any country (Kelley, 2017; UNRWA, 2017). Lebanon is plagued by a history of economic instability, pervasive structural issues including clientelism and corruption, and frequent associated civil turmoil (Malaeb, 2022). These conditions have consistently undermined the delivery of essential services to the Lebanese population and to refugees resident in the country (Malaeb, 2022). The country is currently in the grips of a major economic crisis that has played out alongside a Beirut port explosion in 2020, which reduced key trade capabilities for the country, and the ongoing COVID-19 pandemic, which has interrupted protests within the country calling for reforms across economic, political and social sectors (Kharroubi et al., 2021). The hosting of such a large number of refugees over a protracted length of time in Lebanon further strains the country's existing fragile infrastructure (Malaeb, 2022). While the Lebanese government is supported in its hosting responsibilities by several international and local aid organisations that provide essential relief, development and protection services for refugees resident in the country, fluctuating funding commitments by the international donors that enable these organisations to plan and undertake their activities mean that the needs of these refugees cannot be met sustainably (Kelley, 2017). Further, Lebanon's ambiguous and discriminatory refugee policies continue to undermine refugee wellbeing within the country (Hanafi et al., 2012; Knudsen, 2009). The enacting of any policy recommendations made for this context, then, is necessarily undermined where sufficient funds for meeting the most basic of refugee community needs consistent with ensuring their inviolable human rights in Lebanon are inconsistently committed, and where refugee status remains formally undefined by the Lebanese government.

Final summary of study findings

This study describes a situation of nutritional vulnerability in a group of Palestinian adolescents at the Beddawi camp of North Lebanon, with specific reference to anaemia status. Anaemia prevalence for this group was 29%. This finding highlights the need for follow-up investigation into this vulnerability within the camp. In combination with findings of likely insufficient micronutrient diet diversity, it also suggests that sustainable strategies that ensure increased diversification of adolescent diets at the camp through the increased consumption of food sources high in bioavailable iron may provide an avenue through which iron status might be improved for this group. The promotion of increased dark leafy green consumption by adolescents at the camp, where these plants are accessible, may comprise one such strategy. These foods were found to be exploited very little by the population despite their capacity to contribute significant amounts of iron.

This study found that dark leafy greens were universally valued by food preparers in adolescent households, and this may comprise an opportunity for increased household-level use of these plants that may also contribute further diversity to adolescent diets therein. Food preparers described a host of rationales for valuing plant foods. Further exploration of these rationales may lead additionally to the development of interventions that promote increased consumption from varied plant food groups, including of dark leafy greens. The findings of this study also suggest that food preparer knowledge of the nutrient content of these plant foods and health benefits associated with their consumption may be a promising target for nutrition education interventions that seek to improve adolescent iron status through food-based methods, particularly where plant foods are relied upon to meet the majority of nutrient needs. This may also be extended to include knowledge of iron bioavailability, especially with respect to non-haem iron, and the potential relative impacts of its absorption inhibitors and enhancers. Harnessing these food-based strategies, which are derived from within this community at the Beddawi camp, may offer acceptable avenues through which anaemia risk might be mitigated in this group of adolescent refugees sustainably.

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APPENDIX I

Data collection instrument (English)

ID # (Session 1)

Date + time + location of interview:

Permission for audio recording given?:

Interviewer(s):

---

a

Adolescent participant

Sex of adolescent participant	
Date of birth	
Currently taking medication?	
Currently taking vitamin/mineral supplements?	

How long have you been living at the camp?

Do you currently attend school?

What is the name of the school you attend?

What is your current grade?

For female participants: Have you begun menstruating? If so, when? For male participants: Have you had any recent growth or voice changes? If so, when?	
Hb (g/L)	
Height (cm)	1: 2:
Weight (kg)	1: 2:
Illness in last 2 weeks?	

Adolescent 24-hr recall

Time consumed	Food description	Location	Preparation details	Approximate quantity	Notes on serving
Breakfast 1					
Snack					
Lunch					
Snack					
Dinner					
Snack					
Breakfast 2					
Snack					

Is this your usual diet? (If not, ask: "What do you usually have for breakfast, lunch, dinner, snacks etc.?" List details below.)

---

b

Household food preparer participant

Sex of household food preparer	
Date of birth	
Marital status	
Relationship to adolescent participant	
Household size	Total # in household: Total # in household <18 years:
Currently taking medication?	
Currently taking vitamin/mineral supplements?	

How long have you been living at the camp?

Did you go to school at the camp?

What grade did you reach before leaving school?

Why did you leave school at that stage?

Did your spouse go to school?

What grade did your spouse reach before leaving school?

FP height and weight data:

Height (cm)	1: 2:
Weight (kg)	1: 2:

Plant-source foods prepared in household + preparation and serving details:

Notes on serving	Meal preparation details	Plant source (store, garden, wild etc.)	Plant-based meal

---

Edible wild plant checklist:

Regularity of consumption	**(نعم/لا)**	**النبتة**
		الملوخية jute mallow
		البقدونس parsley
		الكزبرة coriander
		الهندباء (علت) chicory
		القطيفة (أمارانتوس) أربوزة amaranth
		الحمّيضة dock

		البقلة (فرفحينة) purslane
		الخبَّيزة mallow
		الزعتر thyme
		السِّلق silverbeet
		العكّوب gundelia
		النعناع mint
		السبانخ spinach
		الشمر fennel
		الروكا rocket

Do all your children eat these [plant-based] foods?

How did you learn to cook?

Do you feel that plant-based foods are important?

What about them is important to you?

Food security Qs

Food quantity – enough to meet needs (1: Always available, 2: Sometimes unavailable, 3: Often unavailable)?

Food quality – types to suit tastes (1: Always available, 2: Sometimes unavailable, 3: Often unavailable)?

Do you receive any aid (إعاشات)?

From which organisation(s)?

How many people contribute financially to the household?

*** END OF SESSION 1 ***

ID # (Session 2)

Date + time + location of interview:

Permission for audio recording given?:

Interviewer(s):

24-hr recall follow-up 1 – adolescent participant

Time consumed	Food description	Location	Preparation details	Approximate quantity	Notes on serving
Breakfast 1					
Snack					
Lunch					
Snack					
Dinner					
Snack					
Breakfast 2					
Snack					

ID # (Session 3)

Date + time + location of interview:

Permission for audio recording given?:

Interviewer(s):

24-hr recall follow-up 2 – adolescent participant

Time consumed	Food description	Location	Preparation details	Approximate quantity	Notes on serving
Breakfast 1					
Snack					
Lunch					
Snack					
Dinner					
Snack					
Breakfast 2					
Snack					

APPENDIX II

Reflexive thematic analysis full working

Initial code creation

Table 43: Transcript text – Low adolescent Hb group

ID	What about plant-foods is important to you?
12	"It's the tastiest. Tasty and you feel like it's good for the body. [For example,] I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty."
16	"It's healthier than meat or chicken – healthier than anything else – lots healthier."
28	"What we feel like or enjoy, I'll prepare. It's not so much that it is nourishing or beneficial or anything – do you get me? That's how we're accustomed..."
30	"For me, the thing I like so much is to… what I like is to see them [kids] growing tall… a bit… so that, for example, if I have them do tests, they won't have any deficiencies… I want for them to be healthy – I don't want them to become overweight… Like, [in terms of] most foods, I don't let them eat them with bread … I feel that bread contributes to a bit of [over]weight…"
31	"Firstly, its importance is that it's beneficial for the body; it's healthy. And its cooking is uncomplicated; it's not one of those cooking [styles] that is – in truth – burdensome for you to prepare. And the most important, important thing is that it's beneficial/wholesome."
41	"In its iron… because of the iron."
42	"Firstly, it's less expensive, in truth. And secondly, it's nourishment/nutrients for them [the kids]. Like… they like chicken and meat and fish, the kids, more than they like vegetables. But I try [to say] 'no'… vegetables…"
47	"I find that the most benefits are in lentils… in chicken breast.. in meat. Things like pastries, for example, I don't like for them [i.e. her kids] to eat them. And I don't like for them to eat from outside [the house]. Like… whatever they request, I make it for them. For example, things like 'الكريسبس\Crispy*' – I make it for them at home, myself." *Chicken – fried chicken in batter.
48	"They contain a lot of beneficial elements for the body, plant foods."
55	فائدة لجسم الولد. فيها الحديد... فيها الفيتامينات... فيها شغلات للطفل... يعني – لازم ياكل الولد هيك شغلات.
64	"In terms of my kids, the most important thing is that they like it. I feel that its nutritional content "نسبتها الغذائية" is beneficial… It even gives you a feeling of home security; in that *you've* made a nutritional meal – you're reassured; you know what you're feeding your kids."

Table 44: Transcript text – High adolescent Hb group

ID	What about plant-foods is important to you?
9	“They say that plant foods are usually better than meat foods – that’s what I hear.”
11	“More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… It’s easy on the stomach [i.e. in terms of digestion] and it strengthens your blood – [if you have it] you won’t get anaemia.”
18	"يعني – بيصير في غيذاء مُكْتَمِل للأولاد.. لازم يأكلوا كل العناصر – أكلوا من هذا .. أكلوا من هذا.." FP: ‘As much as possible, I like to keep an eye on what they’re eating – make sure they’re eating well.’
20	“Whenever I make them, I focus mostly on … in relation to lemon… the blood – e.g. my husband, he would ask me – ‘[Even] mulūkhiya is eaten with lemon [too]?’ I would tell him, ‘Anything – add lemon to it – in particular, greens – add lemon to them… because it speeds up absorption in the blood – I know that this is the case.’ So he became very keen on it – he’s become like me [about including lemon in his meals].”
27	“They love it a lot, and I prepare it a lot… It strengthens the iron in them [i.e. kids]… this [food type] does it the most… e.g. spinach, spinach increases their iron; I like for them to eat spinach.”
34	“In terms of kids’ growth, their development. Vegetables are beneficial/wholesome – it’s iron for their health.”
36	"غنيّة بالحديد والفيتامينات."
54	“Mallow – blood and iron. Spinach – it’s iron. Lentils are also iron. All of them contain vitamins. But this generation doesn’t eat this. It’s uncommon for this generation to eat things like this. For us, it’s the most important. It’s more important than chicken… Well, the body needs this and that.”
61	“In that, I guess, it’s good for your health – maybe, in terms of, blood – it’s more nutritious for kids… even though they don’t eat it… I’ve started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn’t eat it, except for when I would get it and have it at my parents’ place – e.g. ,المنزّلة*, اللوبيا ببندورة, البامية …” *Tomato-based eggplant-onion stew eaten with flatbread.
63	“In that it’s beneficial in terms of iron etc.; it’s healthy – it’s beneficial for the body, imperative [for it].”
66	“I feel like the body is in need of vegetables, [i.e.] for the digestive system; they have iron, vitamins – not all of it is available just in meats.”

71	"When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]."

Table 45: Initial codes created from transcript text summarised with associated quotes – Low adolescent Hb group

Initial code	Associated excerpt (ID)
C1: Plant-foods are important because they're tasty.	"It's the tastiest." (12) "I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12) "In terms of my kids, the most important thing is that they like it." (64)
C2: Plant-foods are important because you feel they are good for the body.	"…you feel like it's good for the body." (12)
C3: Plant-foods aren't filling, but they're tasty.	"I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12)
C4: Plant-foods are important because they're healthier than meat or chicken.	"It's healthier than meat or chicken – healthier than anything else – lots healthier." (16) "Like… they like chicken and meat and fish, the kids, more than they like vegetables. But I try [to say] 'no'… vegetables…" (42)
C5: Plant foods are the healthiest.	"It's healthier than meat or chicken – healthier than anything else – lots healthier." (16)
C6: Plant-foods are important because of their taste, not nutritional factors.	"What we feel like or enjoy, I'll prepare. It's not so much that it is nourishing or beneficial or anything – do you get me? That's how we're accustomed..." (28)
C7: Plant-foods are important because they promote kids' growth.	"…what I like is to see them [kids] growing tall…" (30)
C8: Plant-foods are important because they protect against nutrient deficiencies.	"… so that, for example, if I have them do tests, they won't have any deficiencies…" (30)

C9: Plant-foods are important because they are nourishing.	"… I want for them [the kids] to be nourished" (30) "And secondly, it's nourishment/nutrients for them [the kids]. Like… they like chicken and meat and fish, the kids, more than they like vegetables. But I try [to say] 'no'… vegetables…" (42) "I feel that its nutritional contents are beneficial…" (64)
C10: Plant-foods are important because they mitigate against becoming overweight.	"I don't want them to become overweight…" (30)
C11: Plant-foods are important because they are beneficial for the body/healthy.	"Firstly, its importance is that it's beneficial for the body; it's healthy." (31) "…the most important, important thing is that it's beneficial/wholesome." (31) "They contain a lot of beneficial elements for the body, plant foods." (48) "فائدة لجسم الولد." (55)
C12: Plant-foods are important because they are not burdensome to prepare.	"…its cooking is uncomplicated; it's not one of those cooking [styles] that is – in truth – burdensome for you to prepare. " (31)
C13: Plant-foods are important because of their iron content.	"In [their] iron… because of the iron." (41) "فيها الحديد..." (55)
C14: Plant-foods are important because they are less expensive.	"Firstly, it's less expensive, in truth." (42)
C15: Home-cooking is preferable to take-out; (Latent) plant-foods are associated with home-cooking and its perceived benefits.	"And I don't like for them to eat from outside [the house]. Like… whatever they request, I make it for them. For example, things like 'الكريسبس\Crispy*' – I make it for them at home, myself." *Chicken – fried chicken in batter." (47) "… It even gives you a feeling of home security; in that *you've* made a nutritional meal – you're reassured; you know what you're feeding your kids." (64)

C16: Plant-foods are important because they contain vitamins.	"...فيها الفيتامينات" (55)
C17: Plant-foods are important because they contain essential things for a kid.	"فيها شغلات للطفل... يعني – لازم ياكل الولد هيك شغلات." (55)

Table 46: Initial codes created from transcript text summarised with associated quotes – High adolescent Hb group

Initial code	Associated excerpt (ID)
CA: Plant-foods are important because they are better than meat foods.	"They say that plant foods are usually better than meat foods – that's what I hear." (9) "More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… " (11) "But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken…" (54)
CB: Plant-foods are important because they are easy on the stomach.	"It's easy on the stomach [i.e. in terms of digestion]…" (11) "I feel like the body is in need of vegetables, [i.e.] for the digestive system…" (66)
CC: Plant-foods are important because they strengthen your blood.	"… it strengthens your blood – [if you have it] you won't get anaemia." (11) "In that, I guess, it's good for your health – maybe, in terms of, blood – " (61) "When I find that there is a deficiency in their blood – the kids…" (71)
CD: Plant-foods are important because they prevent anaemia.	"… it strengthens your blood – [if you have it] you won't get anaemia." (11)
CE: Plant-foods ensure a diversity of nutrients are consumed; they are important because they ensure a child has a complete diet.	"أكلوا من هذا .. أكلوا من هذا.. – لازم يأكلوا كل العناصر ..بيصير في غيذاء مُكْتَمِل للأولاد – يعني.." (18)

CF: (Latent) Absorption of nutrients in plant-foods can be enhanced; they are a particular kind of food group that require different consumption strategies to be of most benefit.	"Whenever I make them, I focus mostly on … in relation to lemon… the blood – e.g. my husband, he would ask me – '[Even] mulūkhiya is eaten with lemon [too]?' I would tell him, 'Anything – add lemon to it – in particular, greens – add lemon to them… because it speeds up absorption in the blood – I know that this is the case.' So he became very keen on it – he's become like me [about including lemon in his meals]." (20)
CG: Plant-foods are important because they are enjoyed.	"They love it a lot, and I prepare it a lot…" (27) "…the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71)
CH: Plant-foods are important because, as a food group, they contribute the most iron to the diet.	"It strengthens the iron in them [i.e. kids]… this [food type] does it the most… e.g. spinach, spinach increases their iron; I like for them to eat spinach." (27)
CI: Plant-foods are important because they contribute iron for kids' growth and development.	"In terms of kids' growth, their development. Vegetables are beneficial/wholesome – it's iron for their health." (34)
CJ: Plant-foods are important because they are rich in iron and vitamins.	"غنيّة بالحديد والفيتامينات" (36) "Mallow – blood and iron. Spinach – it's iron. Lentils are also iron. All of them contain vitamins." (54) "In that it's beneficial in terms of iron etc…" (63) "…they have iron, vitamins – not all of it is available just in meats." (66)
CK: Plant-foods are important because they are nutritious.	"…it's more nutritious for kids…" (61)
CL: Plant-foods are important because they are healthy.	"…it's healthy – it's beneficial for the body, imperative [for it.]" (63)

CM: Plant-foods are important, but there is a generational difference in perceiving them this way.	"But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." (54) "…it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. ,المنزّلة*, اللوبيا ببندورة, البامية …" *Tomato-based eggplant-onion stew eaten with flatbread." (61)

Prospective theme generation

Table 47: Prospective themes developed from initial codes – Low adolescent Hb group

Prospective theme	Codes	Quotes
Taste	C1: Plant-foods are important because they're tasty. C3: Plant-foods aren't filling, but they're tasty. C6: Plant-foods are important because of their taste, not nutritional factors.	"It's the tastiest." (12) "I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12) "In terms of my kids, the most important thing is that they like it." (64) "I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12) "What we feel like or enjoy, I'll prepare. It's not so much that it is nourishing or beneficial or anything – do you get me? That's how we're accustomed..." (28)
Good for health	C2: Plant-foods are important because you feel they are good for the body.	"…you feel like it's good for the body." (12) "…what I like is to see them [kids] growing tall…" (30)

	C7: Plant-foods are important because they promote kids' growth. C9: Plant-foods are important because they are nourishing. C10: Plant-foods are important because they mitigate against becoming overweight. C11: Plant-foods are important because they are beneficial for the body/healthy.	"… I want for them [the kids] to be nourished" (30) "And secondly, it's nourishment/nutrients for them [the kids]. Like… they like chicken and meat and fish, the kids, more than they like vegetables. But I try [to say] 'no'… vegetables…" (42) "I feel that its nutritional contents are beneficial…" (64) "I don't want them to become overweight…" (30) "Firstly, its importance is that it's beneficial for the body; it's healthy." (31) "…the most important, important thing is that it's beneficial/wholesome." (31) "They contain a lot of beneficial elements for the body, plant foods." (48) "فائدة لجسم الولد." (55)
Plant foods are healthier than meat foods	C4: Plant-foods are important because they're healthier than meat or chicken.	"It's healthier than meat or chicken – healthier than anything else – lots healthier." (16) "Like… they like chicken and meat and fish, the kids, more than they like vegetables. But I try [to say] 'no'… vegetables…" (42)
Contain nutrients/prevent nutrient deficiencies	C8: Plant-foods are important because they protect against nutrient deficiencies. C13: Plant-foods are important because of their iron content.	"… so that, for example, if I have them do tests, they won't have any deficiencies…" (30) "In [their] iron… because of the iron." (41) "فيها الحديد..." (55)

	C16: Plant-foods are important because they contain vitamins. C17: Plant-foods are important because they contain essential things for a kid.	"...فيها الفيتامينات" (55) "فيها شغلات للطفل... يعني – لازم ياكل الولد هيك شغلات." (55)
Easy to prepare	C12: Plant-foods are important because they are not burdensome to prepare.	"…its cooking is uncomplicated; it's not one of those cooking [styles] that is – in truth – burdensome for you to prepare. " (31)
Less expensive	C14: Plant-foods are important because they are less expensive.	"Firstly, it's less expensive, in truth." (42)
Miscellaneous	C15: Home-cooking is preferable to take-out; (Latent) plant-foods are associated with home-cooking and its perceived benefits.	"And I don't like for them to eat from outside [the house]. Like… whatever they request, I make it for them. For example, things like 'الكريسبس\Crispy*' – I make it for them at home, myself." *Chicken – fried chicken in batter." (47) "… It even gives you a feeling of home security; in that *you've* made a nutritional meal – you're reassured; you know what you're feeding your kids." (64)

Figure 16: Preliminary thematic map – Low adolescent Hb group

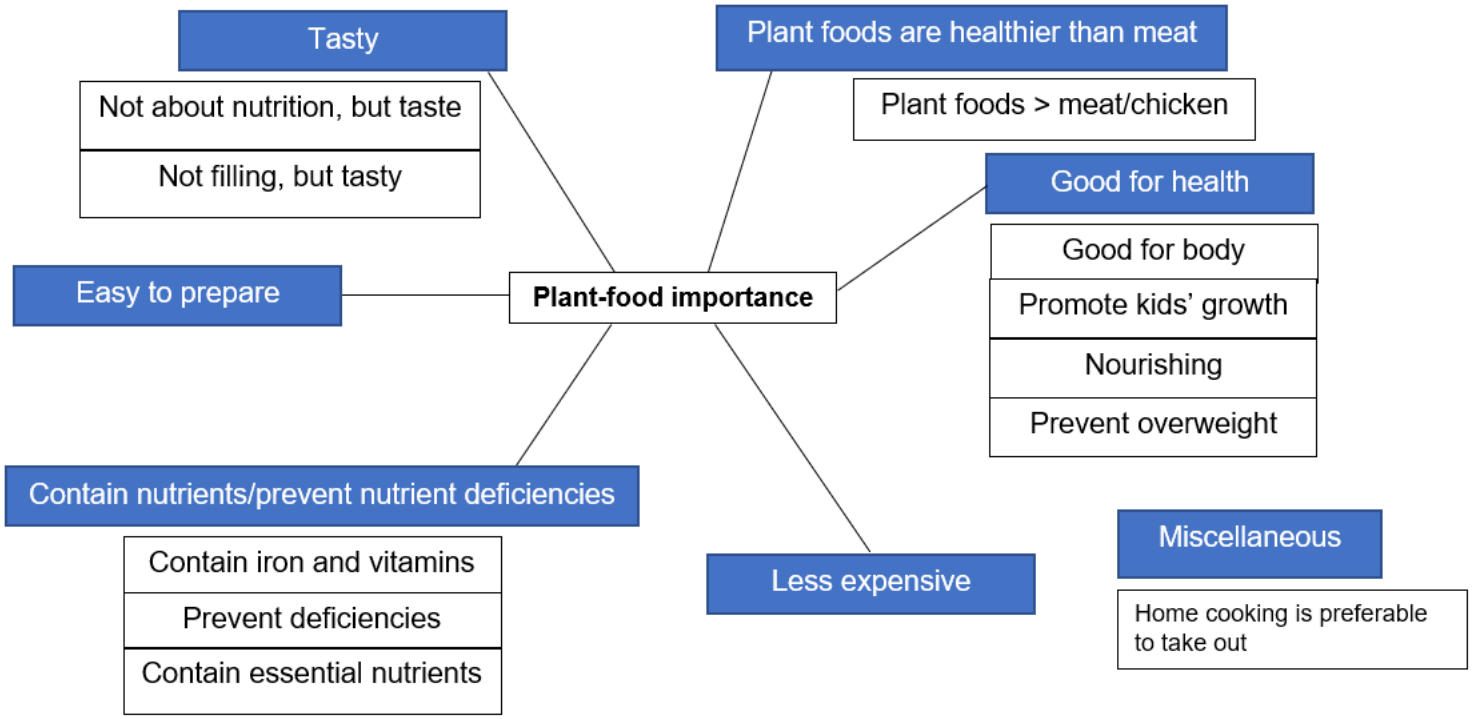


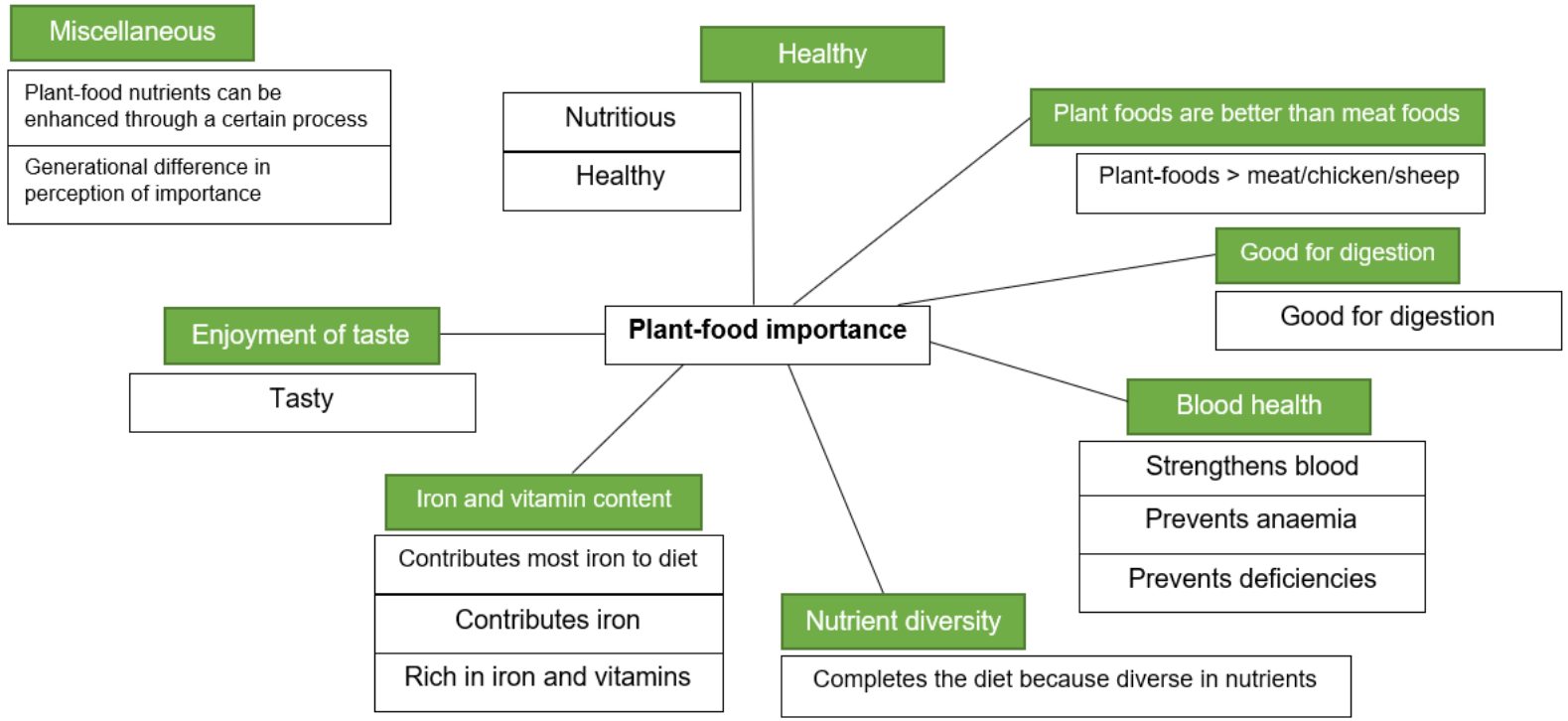
Table 48: Prospective themes developed from initial codes – High adolescent Hb group

Prospective theme	Codes	Quotes
Healthy	CK: Plant-foods are important because they are nutritious. CL: Plant-foods are important because they are healthy.	"…it's more nutritious for kids…" (61) "…it's healthy – it's beneficial for the body, imperative [for it.]" (63)
Enjoyment of taste	CG: Plant-foods are important because they are enjoyed.	"They love it a lot, and I prepare it a lot…" (27) "…the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71)
Iron and vitamin content	CH: Plant-foods are important because, as a food group, they contribute the most iron to the diet. CI: Plant-foods are important because they contribute iron for kids' growth and development. CJ: Plant-foods are important because they are rich in iron and vitamins.	"It strengthens the iron in them [i.e. kids]… this [food type] does it the most… e.g. spinach, spinach increases their iron; I like for them to eat spinach." (27) "In terms of kids' growth, their development. Vegetables are beneficial/wholesome – it's iron for their health." (34) "غنيّة بالحديد والفيتامينات" (36) "Mallow – blood and iron. Spinach – it's iron. Lentils are also iron. All of them contain vitamins." (54) "In that it's beneficial in terms of iron etc…" (63) "…they have iron, vitamins – not all of it is available just in meats." (66)
Nutrient diversity	CE: Plant-foods ensure a diversity of nutrients are consumed; they are important because they ensure a child has a complete diet.	"أكلوا من هذا .. أكلوا من هذا.. – لازم يأكلوا كل العناصر ..بيصير في غيذاء مُكْتَمِل للأولاد – يعني.." (18)

Plant foods are better than meat foods	CA: Plant-foods are important because they are better than meat foods.	"They say that plant foods are usually better than meat foods – that's what I hear." (9) "More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… " (11) "But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken…" (54)
Blood health	CC: Plant-foods are important because they strengthen your blood. CD: Plant-foods are important because they prevent anaemia.	"… it strengthens your blood – [if you have it] you won't get anaemia." (11) "In that, I guess, it's good for your health – maybe, in terms of, blood – " (61) "When I find that there is a deficiency in their blood – the kids…" (71) "… it strengthens your blood – [if you have it] you won't get anaemia." (11)
Good for digestion	CB: Plant-foods are important because they are easy on the stomach.	"It's easy on the stomach [i.e. in terms of digestion]…" (11) "I feel like the body is in need of vegetables, [i.e.] for the digestive system…" (66)
Miscellaneous	CF: (Latent) Absorption of nutrients in plant-foods can be enhanced; they are a particular kind of food group that require different consumption strategies to be of most benefit.	"Whenever I make them, I focus mostly on … in relation to lemon… the blood – e.g. my husband, he would ask me – '[Even] mulūkhiya is eaten with lemon [too]?' I would tell him, 'Anything – add lemon to it – in particular, greens – add lemon to them… because it speeds up absorption in the blood – I know that this is the case.' So he became very keen on it – he's become like me [about including lemon in his meals]." (20)

CM: Plant-foods are important, but there is a generational difference in perceiving them this way.	"But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." (54) "…it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. ,المنزّلة*, اللوبيا بيندورة, البامية …" *Tomato-based eggplant-onion stew eaten with flatbread." (61)

Figure 17: Preliminary thematic map – High adolescent Hb group



Prospective theme review

Table 49: Prospective theme rationale – Low adolescent Hb group

Prospective theme	Central organising concept	What does the theme include vs. exclude? Clear boundaries?	Thin or thick theme?	Coherence?	Final theme name
Taste	Choosing to prepare plant-foods in the household is done predominantly based on taste preferences	- Includes references to taste and enjoyment of plant-foods and the precedence of that over other points of importance - Excludes responses that give health, nutrition and economic rationales predominance over taste - Boundaries are pretty clear: One quote also includes reference to health (ID12); rationale for including ID12 here: FP refers to 'taste' 3 times, 'good for body' once, 'not filling' once and the concept of taste brackets other information	Thick - Meaningful data for answering RQ are contained within the theme - A few respondents (3/11) brought this up	Theme is coherent - Quotes refer to taste and distinguish this from other potential considerations - Where other rationales are given, taste takes precedence or other rationale is contextualised within overall taste rationale (e.g. ID12)	Predominance of taste preferences when valuing plant-foods

Good for health	Plant-foods are important because they are healthy/nourishing and play a role in supporting a child's growth	- Includes responses that link plant-foods to health, nourishment and growth - Excludes responses that give taste and economic rationales for plant importance; excludes taste rationales; also excludes responses that refer to nutrients specifically in terms of plant-food contents and not explicitly tying these to health benefits - Boundaries are clear	Thick - Meaningful data for answering RQ are contained within the theme - Several respondents (8/11) brought up the idea of plant-foods being important for general health and growth	Theme is coherent - Quotes refer to general health benefits that respondents associated with plant-food consumption - Quotes stated that plant-foods were healthy/nourishing/beneficial and more so than meat foods - Quotes also refer to dimensions of child growth (e.g. height and weight)	Plant-foods contribute importantly to optimising general health
Contain nutrients	Plant-foods are important because of the specific nutrients they contain (i.e. iron and vitamins)	- Includes references to specific nutrients and their essentiality - Excludes general references to nourishment/nutrients - Boundaries are clear	Thin - Some meaningful data for answering RQ are contained within the theme - Only a couple of respondents (2/11) brought up this idea, and only briefly	Theme is coherent - Quotes refer to specific nutrients contained in plant-foods	Plant-foods contain essential nutrients
Easy to prepare	Plant-foods are preferable because they are comparatively easy to prepare	- Includes reference to ease of preparation of plant-foods - Excludes taste, health, nutrition and economic rationales - Boundaries are clear	Thin - Meaningful additional dimension to answering RQ - Only one respondent (1/11) mentioned this, and only briefly while	Theme is coherent - Quote refers to ease of preparation, as distinct from other rationales also given by same respondent for plant-food importance (ID31)	Plant-foods are not complicated to prepare

			also discussing health benefits (ID31)		
Less expensive	Plant-foods are important because they are less expensive than other foods	- Includes reference to economic considerations for electing to prepare plant-foods in the household - Excludes taste, health, preparation ease and nutrition rationales - Boundaries are clear	Thin - Meaningful additional dimension to answering RQ - Only one respondent (1/11) mentioned this, and only briefly while also discussing health benefits (ID42)	Theme is coherent - Quote refers to economic consideration for plant-food importance in household - Quote also gives this rationale precedence in her response that also discusses health (ID42)	Food insecurity impacts choice to prepare plant-foods
Miscellaneous	(Latent) Plant-foods are associated with home cooking and home cooking is preferable to take-out for food safety and health reasons	- Includes responses that do not speak directly about plant-food importance but instead distinguished home cooking from take-out - Excludes responses that accept plant-foods as a meaningful category - Boundaries are clear	Thin - Data not meaningful for answering RQ directly, but provide insight into potential additional ways of categorising foods to explore food preparation choices, in general, in the community - A couple of respondents (2/11) made responses that fit this theme	Themes somewhat coherent - Quotes are not explicitly referring to the same idea, and the link has been made more latently than semantically: explicit preference of FP to prepare foods, including take-out foods that her kids enjoy, at home (ID47) vs. FP communicates a sense of satisfaction at preparing foods at home because she is reassured that this way it is more nourishing for her kids (ID64).	Home-cooking, the category into which plant-foods fall, is preferable to take-out foods

Table 50: Updated themes, codes and quotes – Low adolescent Hb group

Prospective theme	Codes	Quotes
Predominance of taste preferences when valuing plant-foods	C1: Plant-foods are important because they're tasty. C3: Plant-foods aren't filling, but they're tasty. C6: Plant-foods are important because of their taste, not nutritional factors.	"It's the tastiest. Tasty and you feel like it's good for the body. [For example,] I feel like when I eat lentil soup – even though it doesn't fill you up – not without bread [alongside] – it's tasty." (12) "In terms of my kids, the most important thing is that they like it." (64) "What we feel like or enjoy, I'll prepare. It's not so much that it is nourishing or beneficial or anything – do you get me? That's how we're accustomed..." (28)
Plant-foods contribute importantly to optimising general health	C2: Plant-foods are important because you feel they are good for the body. C4: Plant-foods are important because they're healthier than meat or chicken. C7: Plant-foods are important because they promote kids' growth. C8: Plant-foods are important because they protect against nutrient deficiencies. C9: Plant-foods are important because they are nourishing. C10: Plant-foods are important because they mitigate against becoming overweight.	"…you feel like it's good for the body." (12) "It's healthier than meat or chicken – healthier than anything else – lots healthier." (16) "For me, the thing I like so much is to… what I like is to see them [kids] growing tall… a bit… so that, for example, if I have them do tests, they won't have any deficiencies… I want for them to be healthy – I don't want them to become overweight… Like, [in terms of] most foods, I don't let them eat them with bread … I feel that bread contributes to a bit of [over]weight…" (30) "And secondly, it's nourishment/nutrients for them [the kids]. Like… they like chicken and meat and fish, the kids, more than they like vegetables. But I try [to say] 'no'… vegetables…" (42) "I feel that its nutritional contents are beneficial…" (64) "Firstly, its importance is that it's beneficial for the body; it's healthy. And its cooking is uncomplicated; it's not one of those cooking [styles] that is – in truth

	C11: Plant-foods are important because they are beneficial for the body/healthy.	– burdensome for you to prepare. And the most important, important thing is that it's beneficial/wholesome." (31) "They contain a lot of beneficial elements for the body, plant foods." (48) "فائدة لجسم الولد." (55)
~~*Plant-foods are healthier than meat foods*~~	*Moved to 'Good for health'*	*Moved to 'Good for health'*
Plant-foods contain essential nutrients	C13: Plant-foods are important because of their iron content. C16: Plant-foods are important because they contain vitamins. C17: Plant-foods are important because they contain essential things for a kid.	"In [their] iron… because of the iron." (41) فائدة لجسم الولد. فيها الحديد... فيها الفيتامينات... فيها شغلات للطفل... يعني – لازم ياكل الولد هيك شغلات." (55)
Plant-foods are not complicated to prepare	C12: Plant-foods are important because they are not burdensome to prepare.	"…its cooking is uncomplicated; it's not one of those cooking [styles] that is – in truth – burdensome for you to prepare. " (31)
Food insecurity impacts choice to prepare plant-foods	C14: Plant-foods are important because they are less expensive.	"Firstly, it's less expensive, in truth." (42)
Home-cooking, the category into which plant-foods fall, is preferable to take-out foods	C15: Home-cooking is preferable to take-out; (Latent) plant-foods are associated with home-cooking and its perceived benefits.	"And I don't like for them to eat from outside [the house]. Like… whatever they request, I make it for them. For example, things like 'الكريسبس\Crispy*' – I make it for them at home, myself." *Chicken – fried chicken in batter." (47) "… It even gives you a feeling of home security; in that *you've* made a nutritional meal – you're reassured; you know what you're feeding your kids." (64)

Figure 18: Updated thematic map – Low adolescent Hb group

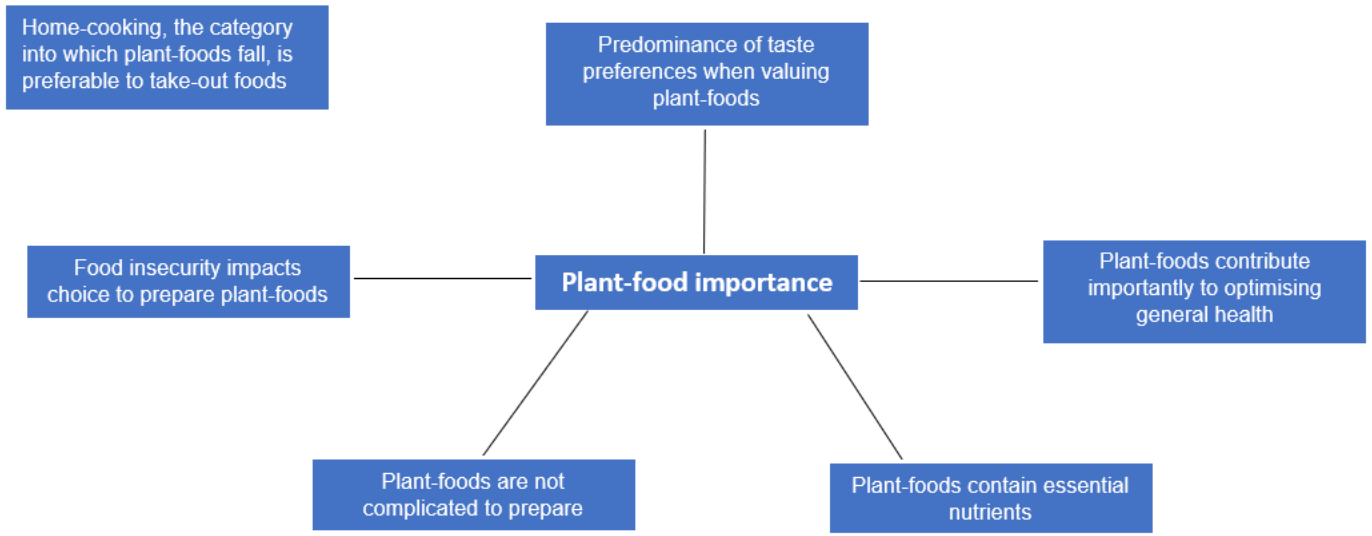


Table 51: Prospective theme rationale – High adolescent Hb group

Prospective theme	Central organising concept	What does the theme include vs. exclude? Clear boundaries?	Thin or thick theme?	Coherence?	Final theme name
Enjoyment of taste	Plant-foods are prepared because the kids enjoy them over other foods	- Includes references to kids enjoying or preferring plant-foods - Excludes rationales based on nutrient content or positive health outcomes - Boundaries are pretty clear: taste referred to while also referencing nutrition (ID27) and health (ID71) benefits; rationale for theme inclusion: concept included as separate addition to explanations of plant-food value, e.g. ID27 speaks of kids' enjoyment of these foods before continuing on to discuss nutrients, and ID71 talks about taste preference as being the reason she would prepare these foods over other nutrient sources (i.e. chicken) if she is worried about blood deficiencies	Thin - Some meaningful data for answering RQ are contained within the theme - Only a couple of respondents (2/12) brought up this idea, and only briefly while also referring to additional benefits	Theme is coherent - Quotes refer to kids' love of plant-foods (ID27) and their preference of these foods over meat alternatives (ID71)	Plant-foods are important because kids in the household enjoy them
Iron and vitamin content	Plant-foods are important because they contain important nutrients	- Includes references to specific nutrients (i.e. iron, vitamins) and their links to health - Excludes references to general deficiencies, blood health or general health without a link to specific nutrients	Thick - Lots of meaningful data for answering RQ are contained within the theme - Many respondents (7/12) discussed iron and vitamins in their responses	Theme is coherent - Quotes refer universally and consistently to specific nutrients, citing plant-food content of these as a	Plant-foods contain essential nutrients

		- Boundaries are pretty clear: ID66 refers also to plant-foods having nutrients that aren't available in meat foods, but it is included here because the respondent is making the comparison for the purpose of highlighting the nutrient content essentiality in plant-foods		key reason for valuing them	
Plant foods are better than meat foods	Plant-foods take precedence over meat foods for nonspecific reasons	- Includes respondents making comparisons between plant and meat foods and electing plant-foods over meat foods, in terms of importance – all as either a standalone point, or a distinct point within a list of valuation points - Excludes plant-food and meat comparisons that also refer specifically to nutrients or to associated health outcomes - Boundaries are somewhat clear: ID11 lists this response ahead of a further rationale that plant-foods prevent anaemia, and so does not firmly sit just in this theme, though it has been placed here as the two points may be two distinct rationales	Thin - Some meaningful, though nonspecific, data for answering the RQ are contained within the theme - Only one respondent exclusively makes this rationale (ID9) (1/12); ID54 begins by giving plant-foods precedence, but at the end of her response, she concedes that 'the body needs this and that', suggesting that one food group does not necessarily take precedence over the other; ID11, again, also lists another rationale about blood health and anaemia prevention	Theme is somewhat coherent - Quotes all draw a comparison between plant and meat foods, but there is not necessarily consensus on the outcomes of the comparison	Plant-foods are an important food category and contribute differently when compared to meat foods
Blood health	Plant-foods are important because they promote blood health	- Includes responses that discuss plant-food improvement of blood health and/or anaemia prevention	Thick - Contains meaningful data for answering RQ	Theme is somewhat coherent - Quotes all discuss blood in relation to	Plant-foods promote blood health

		- Excludes mentions of specific nutrients as contributing to blood health or anaemia prevention - Boundaries are unclear: there is crossover with each of the quotes with another theme category (i.e. plant-foods > meat foods and miscellaneous) **This is probably better as a subtheme**	- A few respondents (4/12) gave elaborated responses on this	plant-food importance to health without also making reference to specific nutrients to draw the complete link between plant-food—nutrients—blood health - While the theme of blood health is coherent, in that it is reported on with some repetition and consistency, unclear boundaries makes it seem unsuitable as a standalone theme	
Good for digestion	Plant-foods are easy on the stomach and good for the digestive system	- Includes rationales on plant-food contribution to digestion comfort, as distinct from other health or nutrition outcomes - Excludes health or nutrition explanations for plant-food value - Boundaries are somewhat clear: mentions of ease of digestion are included along with other rationales, but possibly stand on their own as part of a list of rationales **This may be better as a subtheme**	Thin - Contains meaningful data for answering RQ - Mentioned only twice (2/12) and briefly, at that	Theme is coherent - Quotes are consistent, but always contextualised within another health argument, so not justifiable to have this stand alone as a theme	Plant-foods are good for digestion

Miscellaneous	Plant-foods are of different importance to different generations; there is a loss of a sense of importance over the generations	- Includes meta-discussion of plant-food importance across generations - Excludes responses that directly answer the question about plant-food importance by rationalising nutrition, health and taste outcomes - Boundaries are somewhat clear: both responses also mention health and nutrition benefits of plant-foods before continuing on to report on generational differences on perceiving plant-foods as important	Thin - Does not contain much meaningful data for answering RQ directly - Does open up an additional line of important inquiry about plant-food importance being dependent on generation	Theme is pretty coherent - Both quotes discuss generational differences, though one does so explicitly (ID54 – Semantic) and the other does so more implicitly (ID61 – Latent)	There are generational differences in the way plant-foods are valued

Table 52: Updated themes, codes and quotes – High adolescent Hb group

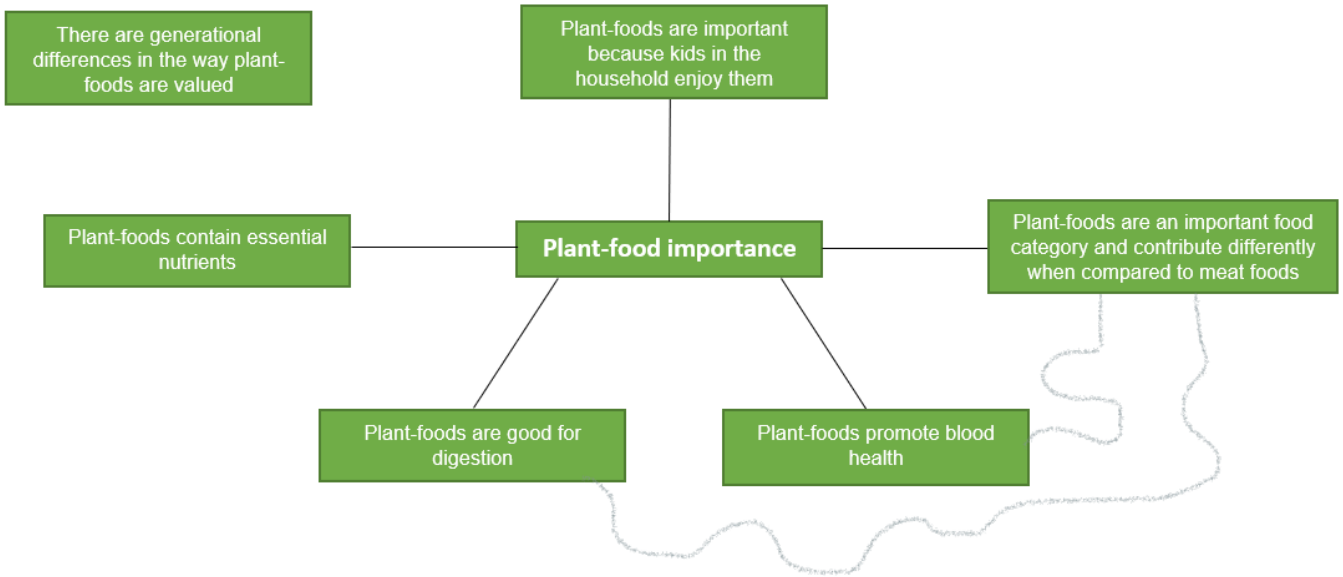
Prospective theme	Codes	Quotes
~~*Healthy*~~	~~CK: Plant-foods are important because they are nutritious.~~ ~~CL: Plant-foods are important because they are healthy.~~	~~"…it's more nutritious for kids…" (61)~~ ~~"…it's healthy – it's beneficial for the body, imperative [for it.]" (63)~~
Plant-foods are important because kids in the household enjoy them	CG: Plant-foods are important because they are enjoyed.	"They love it a lot, and I prepare it a lot…" (27) "When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71)
Plant-foods contain essential nutrients	CE: Plant-foods ensure a diversity of nutrients are consumed; they are important because they ensure a child has a complete diet.	"بيصير في غيذاء مُكْتَمِل للأولاد – يعني.. أكلوا من هذا .. أكلوا من هذا.. – لازم يأكلوا كل العناصر.." (18)

	CH: Plant-foods are important because, as a food group, they contribute the most iron to the diet. CI: Plant-foods are important because they contribute iron for kids' growth and development. CJ: Plant-foods are important because they are rich in iron and vitamins.	"It strengthens the iron in them [i.e. kids]… this [food type] does it the most… e.g. spinach, spinach increases their iron; I like for them to eat spinach." (27) "In terms of kids' growth, their development. Vegetables are beneficial/wholesome – it's iron for their health." (34) "غنيّة بالحديد والفيتامينات" (36) "Mallow – blood and iron. Spinach – it's iron. Lentils are also iron. All of them contain vitamins." (54) "In that it's beneficial in terms of iron etc.; it's healthy – it's beneficial for the body, imperative [for it]." (63) "… they have iron, vitamins – not all of it is available just in meats." (66)"
~~*Nutrient diversity*~~	*Moved to 'Iron and vitamin content'*	*Moved to 'Iron and vitamin content'*
Plant-foods are an important food category and contribute differently when compared to meat foods	CA: Plant-foods are important because they are better than meat foods.	"They say that plant foods are usually better than meat foods – that's what I hear." (9) "More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… " (11) "But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." (54) "I feel like the body is in need of vegetables, [i.e.] for the digestive system; they have iron, vitamins – not all of it is available just in meats." (66)

		"When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71)
Plant-foods promote blood health	CC: Plant-foods are important because they strengthen your blood. CD: Plant-foods are important because they prevent anaemia. CF: (Latent) Absorption of nutrients in plant-foods can be enhanced; they are a particular kind of food group that require different consumption strategies to be of most benefit.	"More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… it strengthens your blood – [if you have it] you won't get anaemia." (11) "Whenever I make them, I focus mostly on … in relation to lemon… the blood – e.g. my husband, he would ask me – '[Even] mulūkhiya is eaten with lemon [too]?' I would tell him, 'Anything – add lemon to it – in particular, greens – add lemon to them… because it speeds up absorption in the blood – I know that this is the case.' So he became very keen on it – he's become like me [about including lemon in his meals]." (20) "In that, I guess, it's good for your health – maybe, in terms of, blood – it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. المنزّلة*, اللوبيا بيندورة, البامية …" *Tomato-based eggplant-onion stew eaten with flatbread. (61) "When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71)
Plant-foods are good for digestion	CB: Plant-foods are important because they are easy on the stomach.	"It's easy on the stomach [i.e. in terms of digestion]…" (11) "I feel like the body is in need of vegetables, [i.e.] for the digestive system; they have iron, vitamins – not all of it is available just in meats." (66)

There are generational differences in the way plant-foods are valued	CM: Plant-foods are important, but there is a generational difference in perceiving them this way.	"But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." (54) "…it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. ,المنزّلة البامية*, اللوبيا ببندورة …" *Tomato-based eggplant-onion stew eaten with flatbread." (61)

Figure 19: Updated thematic map – High adolescent Hb group



NOTE: Digestion and blood health themes are related to the plant-food vs. meat food theme, and may be better as subthemes within that theme.

Table 53: Updated prospective theme rationale – High adolescent Hb group

Prospective theme	Central organising concept	What does the theme include vs. exclude? Clear boundaries?	Thin or thick theme?	Coherence?	Final theme name
Enjoyment of taste	Plant-foods are prepared because the kids enjoy them over other foods	- Includes references to kids enjoying or preferring plant-foods - Excludes rationales based on nutrient content or positive health outcomes - Boundaries are pretty clear: taste referred to while also referencing nutrition (ID27) and health (ID71) benefits; rationale for theme inclusion: concept included as separate addition to explanations of plant-food value, e.g. ID27 speaks of kids' enjoyment of these foods before continuing on to discuss nutrients, and ID71 talks about taste preference as being the reason she would prepare these foods over other nutrient sources (i.e. chicken) if she is worried about blood deficiencies	Thin - Some meaningful data for answering RQ are contained within the theme - Only a couple of respondents (2/12) brought up this idea, and only briefly while also referring to additional benefits	Theme is coherent - Quotes refer to kids' love of plant-foods (ID27) and their preference of these foods over meat alternatives (ID71)	Plant-foods are important because kids in the household enjoy them
Iron and vitamin content	Plant-foods are important because they contain important nutrients	- Includes references to specific nutrients (i.e. iron, vitamins) and their links to health	Thick - Lots of meaningful data for answering RQ	Theme is coherent - Quotes refer universally and consistently to specific nutrients, citing plant-food	Plant-foods contain essential nutrients

		- Excludes references to general deficiencies, blood health or general health without a link to specific nutrients - Boundaries are clear	are contained within the theme - Many respondents (6/12) discussed iron and vitamins in their responses	content of these as a key reason for valuing them	
Plant foods are better than meat foods **+** **SUBTHEME 1: Blood health** **+** **SUBTHEME 2: Good for digestion**	Plant-foods are an important complementary group to meat foods because they promote general health in their own ways	- Includes respondents making comparisons between plant and meat foods and/or electing plant-foods over meat foods, in terms of importance – with or without additional comments on health promotion extensions to this comparison - Excludes nutrient references that are not tied to general health, blood health or digestion outcomes	Thick - Meaningful data for answering the RQ are contained within the theme - General situating of plant-foods in comparison to meat foods is explored in a few responses (3/12), and further detail in the form of distinct subthemes is explored by a few other respondents (4/12)	Theme is coherent - Quotes all draw a comparison between plant and meat foods - Respondents offer a range of rationales in making their comparisons	Plant-foods are an important food category and contribute differently when compared to meat foods
SUBTHEME 1: Blood health	Plant-foods are important because they promote blood health	- Includes responses that discuss plant-food improvement of blood health and/or anaemia prevention, contextualised within a plant-food—meat-food comparison - Excludes mentions of specific nutrients as contributing to blood health or anaemia prevention	Thick - Contains meaningful data for answering RQ - A few respondents (4/12) gave elaborated responses on this	Subtheme is coherent - Quotes all discuss blood in relation to plant-food importance to health without also making reference to specific nutrients to draw the complete link between plant-food—nutrients—blood health	Plant-foods promote blood health

		- Boundaries are clear: the subtheme within its parent theme is distinct from other themes; the blood health subtheme is distinct from the digestion subtheme			
SUBTHEME 2: Good for digestion	Plant-foods are easy on the stomach and good for the digestive system	- Includes rationales on plant-food contribution to digestion comfort, as distinct from other health or nutrition outcomes, contextualised within a plant-food—meat-food comparison - Excludes health or nutrition explanations for plant-food value - Boundaries are clear: the subtheme within its parent theme is distinct from other themes; the digestion subtheme is distinct from the blood health subtheme	Thin - Contains meaningful data for answering RQ - Mentioned only twice (2/12) and briefly, at that	Subtheme is coherent - Quotes are consistent in rationalising plant-food importance in relation to digestion within the context of a comparison of the plant-food group with the meat food-group	Plant-foods are good for digestion
Miscellaneous	Plant-foods are of different importance to different generations; there is a loss of a sense of importance over the generations	- Includes meta-discussion of plant-food importance across generations - Excludes responses that directly answer the question about plant-food importance by rationalising nutrition, health and taste outcomes - Boundaries are somewhat clear: both responses also mention health and nutrition benefits of plant-foods before	Thin - Does not contain much meaningful data for answering RQ directly - Does open up an additional line of important inquiry about plant-food importance being dependent on generation	Theme is pretty coherent - Both quotes discuss generational differences, though one does so explicitly (ID54 – Semantic) and the other does so more implicitly (ID61 – Latent)	There are generational differences in the way plant-foods are valued

		continuing on to report on generational differences on perceiving plant-foods as important			

Table 54: Finalised themes, subthemes, codes and quotes – High adolescent Hb group

Prospective theme	Codes	Quotes
Plant-foods are important because kids in the household enjoy them	CG: Plant-foods are important because they are enjoyed.	"They love it a lot, and I prepare it a lot…" (27) "When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71)
Plant-foods contain essential nutrients	CE: Plant-foods ensure a diversity of nutrients are consumed; they are important because they ensure a child has a complete diet. CH: Plant-foods are important because, as a food group, they contribute the most iron to the diet. CI: Plant-foods are important because they contribute iron for kids' growth and development.	"بيصير في غيذاء مُكْتَمِل للأولاد – يعني.. أكلوا من هذا .. أكلوا من هذا.. – لازم يأكلوا كل العناصر.." (18) "It strengthens the iron in them [i.e. kids]… this [food type] does it the most… e.g. spinach, spinach increases their iron; I like for them to eat spinach." (27) "In terms of kids' growth, their development. Vegetables are beneficial/wholesome – it's iron for their health." (34)

CJ: Plant-foods are important because they are rich in iron and vitamins.	"غنيّة بالحديد والفيتامينات" (36) "Mallow – blood and iron. Spinach – it's iron. Lentils are also iron. All of them contain vitamins." (54) "In that it's beneficial in terms of iron etc.; it's healthy – it's beneficial for the body, imperative [for it]." (63)

Plant-foods are an important food category and contribute differently when compared to meat foods	CA: Plant-foods are important because they are better than meat foods.	"They say that plant foods are usually better than meat foods – that's what I hear." (9)
	CC: Plant-foods are important because they strengthen your blood.	"More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… " (11)
	CD: Plant-foods are important because they prevent anaemia.	"But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." (54)
Plant-foods promote blood health	CF: (Latent) Absorption of nutrients in plant-foods can be enhanced; they are a particular kind of food group that require different consumption strategies to be of most benefit.	"More important than anything else – more important than meat… more important than chicken… more important than a whole sheep… it strengthens your blood – [if you have it] you won't get anaemia." (11)
Plant-foods are good for digestion	CB: Plant-foods are important because they are easy on the stomach.	"Whenever I make them, I focus mostly on … in relation to lemon… the blood – e.g. my husband, he would ask me – '[Even] mulūkhiya is eaten with lemon [too]?' I would tell him, 'Anything – add lemon to it – in particular, greens – add lemon to them… because it speeds up absorption in the blood – I know that this is the case.' So he became very keen on it – he's become like me [about including lemon in his meals]." (20)
		"In that, I guess, it's good for your health – maybe, in terms of, blood – it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. , اللوبيا المنزّلة*, بيندورة, البامية … " *Tomato-based eggplant-onion stew eaten with flatbread. (61)

	"When I find that there is a deficiency in their blood – the kids – they don't like foods made with chicken a lot – [that's when] I make [these foods]." (71) "It's easy on the stomach [i.e. in terms of digestion]…" (11) "I feel like the body is in need of vegetables, [i.e.] for the digestive system; they have iron, vitamins – not all of it is available just in meats." (66)

There are generational differences in the way plant-foods are valued	CM: Plant-foods are important, but there is a generational difference in perceiving them this way.	"But this generation doesn't eat this. It's uncommon for this generation to eat things like this. For us, it's the most important. It's more important than chicken… Well, the body needs this and that." (54) "…it's more nutritious for kids… even though they don't eat it… I've started to feel that they should be eating it. Even me – this sort of stuff, most of it, there was period in which I didn't eat it, except for when I would get it and have it at my parents' place – e.g. المنزّلة*, اللوبيا ببندورة, البامية …" *Tomato-based eggplant-onion stew eaten with flatbread." (61)

Figure 20: Final thematic map – High adolescent Hb group

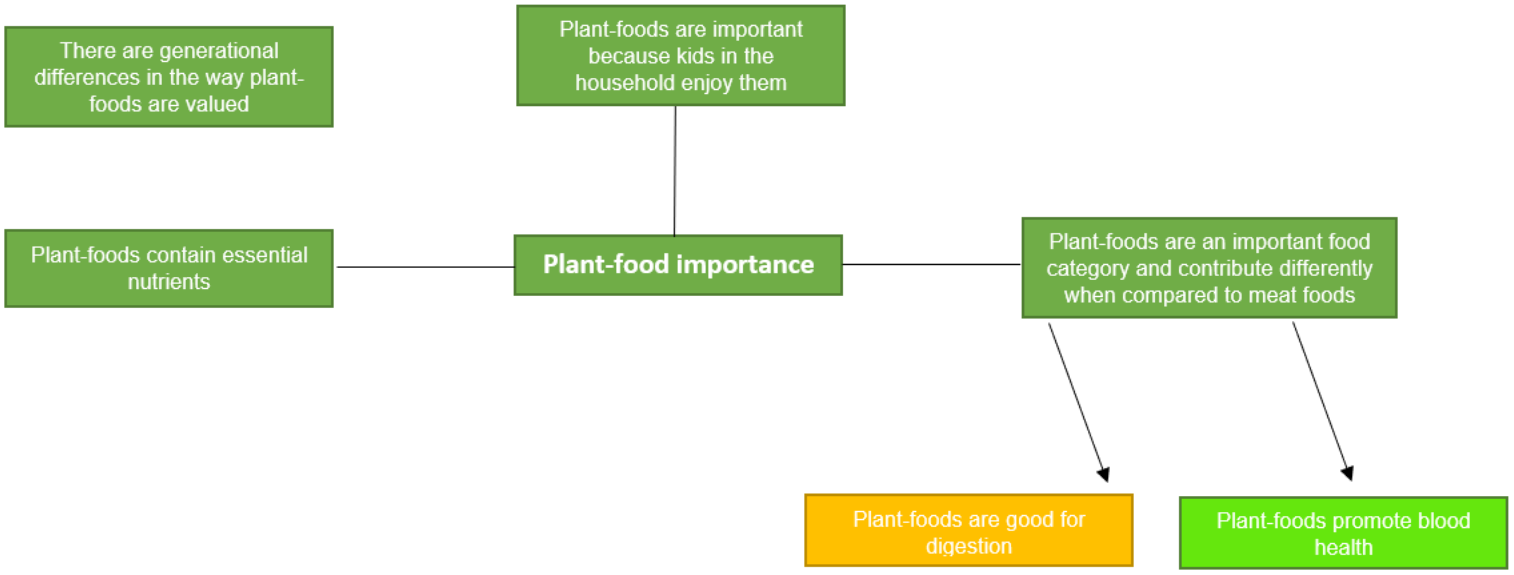


Table 55: Theme development summary: prospective to final – Low adolescent Hb group

Prospective theme	Updated theme	Final theme
Taste	Predominance of taste preferences when valuing plant-foods	Predominance of taste preferences when valuing plant-foods
Good for health	Plant-foods contribute importantly to optimising general health	Plant-foods contribute importantly to optimising general health
Plant foods are healthier than meat foods	Cut as independent theme; codes and quotes subsumed under *Good for health* prospective theme	N/A
Contain nutrients/prevent nutrient deficiencies	Plant-foods contain essential nutrients	Plant-foods contain essential nutrients
Easy to prepare	Plant-foods are not complicated to prepare	Plant-foods are not complicated to prepare
Less expensive	Food insecurity impacts choice to prepare plant-foods	Food insecurity impacts choice to prepare plant-foods
Miscellaneous	Home-cooking, the category into which plant-foods fall, is preferable to take-out foods	Home-cooking, the category into which plant-foods fall, is preferable to take-out foods

Table 56: Theme development summary: prospective to final – High adolescent Hb group

Prospective theme	Updated theme	Final theme
Healthy	Cut as independent theme; quotes subsumed under *Blood health* and *Iron and vitamin content* prospective themes	N/A
Enjoyment of taste	Plant-foods are important because kids in the household enjoy them	Plant-foods are important because kids in the household enjoy them
Iron and vitamin content	Plant-foods contain essential nutrients	Plant-foods contain essential nutrients
Nutrient diversity	Cut as independent theme; codes and quotes subsumed *Iron and vitamin content* prospective theme	N/A
Plant foods are better than meat foods	Plant-foods are an important food category and contribute differently when compared to meat foods	Plant-foods are an important food category and contribute differently when compared to meat foods - Contains two subthemes: 1) Plant-foods promote blood health 2) Plant-foods are good for digestion
Blood health	Plant-foods promote blood health	Subtheme within *Plant-foods are an important food category and contribute differently when compared to meat foods* parent theme
Good for digestion	Plant-foods are good for digestion	Subtheme within *Plant-foods are an important food category and contribute*

		differently when compared to meat foods parent theme
Miscellaneous	There are generational differences in the way plant-foods are valued	There are generational differences in the way plant-foods are valued

Theme name finalisation

Figure 21: Final thematic map with associated quotes – Low adolescent Hb group

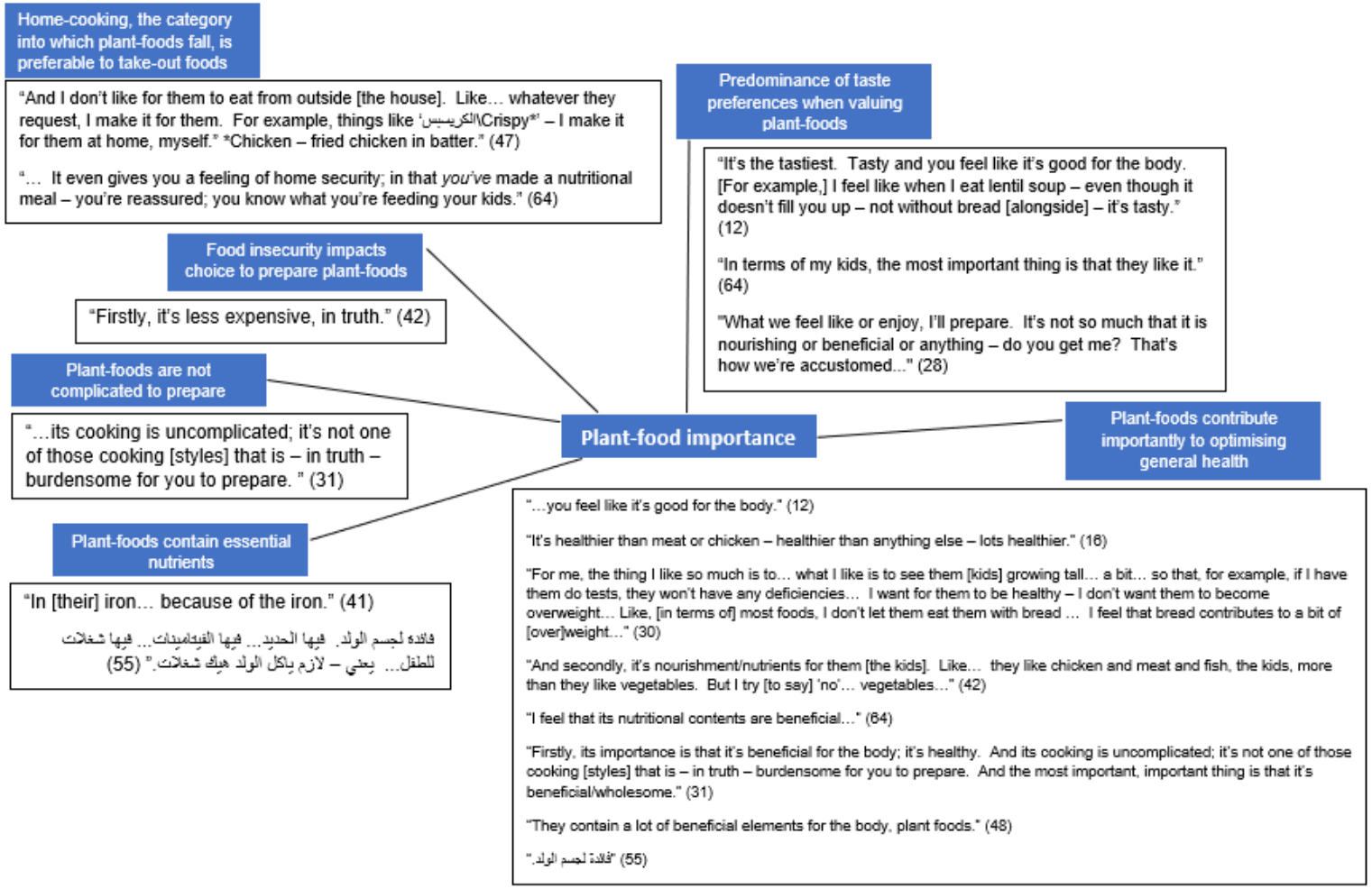


Figure 22: Final thematic map with associated quotes – High adolescent Hb group