

Mount Saint Vincent University
Department of Applied Human Nutrition

**A mixed-methods exploration of peripartum food taboos and food additions
in rural Cambodia**

by
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Abstract

Background: Food taboos are culturally driven food avoidances that go beyond personal taste or preference. These avoidances are particularly prevalent throughout pregnancy and lactation. In Southeast Asia, common peripartum food taboos include seafood, meats, and various vegetables. Such avoidances could negatively impact the health of women and children if foods of similar nutritional value do not replace avoided foods. There is a paucity of information on dietary modifications during pregnancy and lactation in Cambodia.

Objectives: To describe food avoidances and food additions throughout pregnancy and lactation in Kampong Thom, Cambodia and to provide women's rationale for these dietary changes. Also, to determine whether these modifications align with the Cambodian government's peripartum dietary recommendations, and to identify predictors of these food avoidances and additions.

Methods: This study was a mixed-methods secondary analysis of data collected in the *Trial of Thiamine Supplementation in Cambodia* between September 2018 and May 2019. As part of the larger study, 335 women were asked open-ended questions to capture dietary modifications during pregnancy and at two, 12, and 24 weeks postpartum. Descriptive statistics and content analysis were used to characterize peripartum foods taboos and food additions, and multiple logistic regression analyses were conducted to identify potential sociodemographic and health predictors of maternal dietary modifications.

Results: Sixty-six percent of women avoided at least one type of food or beverage during the first two weeks postpartum, while fewer than one in five women avoided foods during other peripartum periods. Postpartum avoidances typically opposed dietary recommendations, as common avoidances included fish without scales, raw vegetables, chicken, and beef. Pregnancy avoidances often aligned with dietary recommendations, with items such as energy drinks, coffee, and alcohol being avoided. Food additions were more common than food avoidances, with 32-45% of women adding at least one food or beverage to their diets during the peripartum period. Additions tended to include nutritious foods like meat- and fish-based soups, soymilk, and milk. Maternal dietary modifications were chiefly practiced to support the health of women and children. No predictors of food avoidances or additions were identified during pregnancy. The only predictor for postpartum dietary modifications was parity: for each additional birth, the odds of women following food taboos were reduced by 24% (OR [95% CI]: 0.76 [0.61-0.95]), while the odds of adding foods were reduced by 20% (0.80 [0.64-0.99]).

Conclusion: Food taboos were practiced throughout pregnancy and postpartum, yet they were limited in duration and severity. Peripartum food taboos observed in this exploratory study do not appear to present a substantial risk to the health of most women and children in Kampong Thom, however health professionals should continue to address maternal dietary practices during antenatal visits. Findings from this study can inform person-centered health programs that target the common practices and concerns of pregnant and lactating women in Cambodia.

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List of Abbreviations

| | |
|-------|--|
| AI | Adequate intake |
| AMDR | Acceptable macronutrient distribution range |
| ANOVA | Analysis of variance |
| CDHS | Cambodia Demographic and Health Survey |
| CI | Confidence interval |
| CMNS | Cambodian Micronutrient Survey |
| DRI | Dietary reference intakes |
| EAR | Estimated average requirement |
| EER | Estimated energy requirement |
| EGRac | Erythrocyte glutathione reductase activity coefficient ratio |
| eThDP | Erythrocyte thiamine diphosphate |
| FAO | Food and Agriculture Organization |
| IQR | Interquartile range |
| LBW | Low birth weight |
| LMIC | Low- and middle-income countries |
| MDER | Minimum dietary energy requirement |
| MDD-W | Minimum dietary diversity for women |
| MPA | Minimum Package of Activities |
| OR | Odds ratio |
| RDA | Recommended dietary allowance |
| RNI | Recommended nutrient intake |

| | |
|---------|---|
| SD | Standard deviation |
| SEA-RDA | Southeast Asian recommended dietary allowance |
| UL | Tolerable upper intake level |
| WFP | World Food Programme |
| WHO | World Health Organization |

Glossary of Khmer Terms

| | |
|----------------------|---|
| <i>Ang pleung</i> | Mother roasting, a postpartum ritual in which women lie on a bed set over a fire or hot coals for multiple days |
| <i>Chbab srei</i> | The traditional Khmer code of conduct for women |
| <i>Chek ambong</i> | The most widely cultivated type of banana in Cambodia |
| <i>Chek nuon</i> | A type of banana commonly cultivated in Cambodia |
| <i>Chlong tonlee</i> | Khmer term for childbirth, which translates to “crossing the river”; both undertakings are viewed as potentially dangerous |
| <i>Kru khmer</i> | Traditional Khmer healer who works with traditional medicines |
| <i>Prahok</i> | Fermented fish paste |
| <i>Toa</i> | Physical and psychological illness experienced by postpartum women; symptoms include seizures, headaches, and abdominal pains |
| <i>Voar yeav</i> | Flowering plant commonly found in Southeast Asia; the leaves of this plant are used to make the Cambodian sour soup <i>samlar machu</i> |

1.0 Introduction

Food taboos are avoidances that go beyond personal taste or preference (1). They are culturally dependent, finding root in religion, spirituality, magical beliefs, or utilitarian motives (1). Such avoidances are particularly prevalent throughout pregnancy and lactation, often driven by the fear of causing harm to the mother or infant (2). While some food avoidances are desirable throughout pregnancy (e.g., elimination of sushi or brie, which pose a high risk of bacterial contamination), others may have unintended consequences. A 2019 systematic review highlighted that seafood is a prominent food taboo during pregnancy throughout Southeast Asia; yet elimination means that women would omit rich sources of protein, fats, and other nutrients necessary for fetal development (2). This risk of nutritional inadequacy warrants the exploration of food taboos that are present in various countries.

The breadth and impact of food taboos in Cambodia have not been thoroughly explored. Foods believed to be restricted throughout pregnancy include coconut milk, porridge (3), certain varieties of rice (4), and spicy foods (5). Postpartum restrictions include certain species of fish, *chek nuon* (type of banana), *prahok* (fermented fish paste) (5), pineapple, and buffalo meat (6). The prevalence of food taboos in Cambodia is unknown, as are the sociodemographic characteristics of women who tend to follow these taboos. It is also unclear whether avoided foods are intentionally replaced by other foods in the maternal diet, potentially counterbalancing the nutritional impact of food taboos. The purpose of this study will be to explore the food taboos and food additions of pregnant and lactating women in Cambodia.

2.0 Literature Review

2.1 Cambodia

The Kingdom of Cambodia is a Southeast Asian country situated between Laos, Vietnam, Thailand, and the Gulf of Thailand (7). The landscape is dominated by plains, the Mekong and Tonlé Sap rivers, and the great Tonlé Sap lake (see **Figure 2-1**) (7). While the population lives predominantly in rural settings, urbanization is rising; in 2019-20, 39% of the population lived in an urban area, compared to 22% in 2014 (8). Phnom Penh, the capital city of Cambodia, is the country's only metropolis (7). Cambodia's population has also been increasing, with an average annual population growth rate of 1.5% for the past 20 years (8). In 2019, the census recorded 15.5 million citizens (9).



Figure 2-1. Map of Cambodia, public domain.

Cambodia's populace is largely homogenous: 95% of individuals are of Khmer ethnicity (8) and 93% are Theravada Buddhists (7). This population has retained a strong national identity despite its tumultuous recent history (7). Cambodia gained independence from France in 1953. Soon thereafter, the Vietnam War erupted, leading to heightened political tensions in neighbouring Cambodia; in 1970, a civil war broke out (7,10). In 1975, the communist guerilla group Khmer Rouge gained control of Cambodia. Citizens were forcibly marched out of urban areas, unpaid labour became compulsory, religion was banned, and many educated citizens were executed as perceived threats to the new government (7,10–12). The Khmer Rouge is responsible for the death of about 20% of the population during their four-year rule between 1975 and 1979 (7,10–12). The trauma inflicted by the Khmer Rouge persists in Cambodia; much of the country's poverty is attributed to the destruction of that regime (12).

Cambodia is classified by the World Bank as a lower-middle income country, transitioning from low-income status in 2015 (13). The Cambodian government is vying to gain classification as an upper-middle income country by 2030. Expansions in tourism, manufacturing exports, and construction have made Cambodia one of the fastest-growing economies in the world (13). Despite these national economic advancements, Cambodia's population is largely considered low income (8): 18% of individuals live below the national poverty line (14), and approximately one-quarter are vulnerable to falling into poverty (8). The government of Cambodia has identified a need to improve its national social protection system (15,16). The current system has multiple gaps related to pregnancy, childhood, and health, and is limited in its reach (15). A patchwork of pilot projects, funded and managed by the government and its development partners, can be found across Cambodia (13,15,16). The government aims to integrate these

projects into one cohesive system to reduce and prevent poverty, vulnerability, and inequality in Cambodia (15).

2.2 Diet in Cambodia

The Cambodian diet is shaped by the country's landscape. The central plains region of Cambodia is favourable for rice production, as the annual flooding of the Mekong River nourishes the soils and provides natural irrigation for cultivation (7). Polished rice is the principal food produced and consumed in Cambodia; it accounts for 55% of the country's agricultural production (8) and is eaten at least twice daily by most individuals (mean intake of 712 g/day for women and 1,022 g/men) (17). Fish is the second-largest dietary staple in Cambodia, owing to the vast rivers and the Tonlé Sap, one of the Earth's richest sources of freshwater fish (7). National surveys have recorded mean daily fish intakes between 75 g (17) and 173 g (18) per person. Fresh, dried, smoked, and salted forms of perch, carp, lungfish, and smelt are consumed in a typical Cambodian diet (8). Overall, fish contribute to approximately 12% of the daily caloric intake (18), while rice accounts for upwards of 60% (18,19). Meats, poultry, vegetables, and fruit are also added to the diet, with tubers, nuts, seeds, and legumes being consumed in smaller amounts (8,17). The profile of the typical Cambodian diet remains relatively stable throughout the year, despite the seasonal weather fluctuations (17), with wet season from June to October, dry season from November to May (20). In *et al.* (2015) observed a significant increase in the consumption of rice, vegetables, starchy roots/tuber, condiments, and spices during the wet season, but concluded that "overall, food consumption of the Cambodian population was quite similar during the wet and dry seasons" (17).

Geographic location appears to be an influential factor for dietary patterns. The study by In *et al.* mentioned above suggests a higher intake of fruit and meat in urban Phnom Penh as compared to rural regions of Cambodia (17). In the southern coast region, a higher consumption of fish paired with a lower consumption of fruit and vegetables was observed, while along the Mekong river, rice intakes were higher (17). Education, income, and accessibility of food items are potential contributors to these regional differences (17), along with the level of rurality. Cambodia's *Socio-Economic Survey* of 2019-20 suggests that the consumption of most foods is similar between rural and urban households (8), but this finding is not corroborated by all studies. For instance, a 2019 study of children aged six to 17 years found that rural children consumed less fat, protein, and iron, and more carbohydrates, than urban children (e.g., mean (standard deviation, SD) fat consumption of 25.8 (0.4) g/day in rural children vs. 32.3 (0.8) g/day in urban children, $p < 0.01$) (21). Additionally, the 2014 *Cambodia Demographic and Health Survey* (CDHS) indicates that children aged six to 23 months living in urban settings were more likely to be fed according to recommended infant and young child feeding practices than those living in rural areas (49% vs. 28%, respectively) (22). Differences in food security may mediate the observed variations in eating patterns as Cambodian households in rural regions, and those with a low income, are at higher risk of food insecurity (23).

2.2.1 Food security

The Food and Agriculture Organization (FAO) of the United Nations (UN) describes food security using four dimensions: food availability, access, utilization, and stability (24). Issues within each of these dimensions have been identified in Cambodia. Over 85% of households engage in subsistence farming; therefore, factors that constrain capacity to grow crops, raise

livestock, or fish can severely impact the availability of food (23). Such factors include low crop yields, dependency on adequate rainfall, high livestock mortality rates, and high production costs (25). Seasonality also affects food availability, particularly for Cambodians who reside far from the coast or rivers (26). Fish is more readily available during the wet season as flooding brings fish into the rice paddies, thereby facilitating the harvesting of this food source (26). Food access is primarily constrained by households' insufficient and irregular income (5,27) paired with increasing food prices (25). One in five Cambodians cannot afford a nutritionally adequate diet as much of the nutrient-rich foods that diversify the diet are purchased from the market (23). Limited access to cooking fuels has been noted as a barrier to food use, challenging food utilization (28). Other important factors related to this dimension include inadequate access to sanitation and suboptimal hygiene practices in rural regions (25). Finally, food stability is threatened in Cambodia through stresses to the ecological system. Episodes of drought and flooding have become more prevalent in Cambodia, threatening agricultural activity throughout the country (25). Additionally, fish stocks are reportedly declining due to overfishing, environmental degradation (7), and the construction of large dams throughout the Mekong River (18,29,30). These threats present a growing challenge to food security in Cambodia.

A recent qualitative study explored the experiences of food insecurity within low-income urban populations in Phnom Penh and Prey Veng (southern Cambodia) (31). Participants ($n=80$) revealed that food security was one of their biggest challenges and that this burden often fell on the women in households. Food acquisition was the highest household cost and required substantial expenditures of time and labour. Participants described a constant variability in food intake based on the family's income and circumstances for that day; they outlined three sample

menus to represent the types of foods consumed within their household based on daily access and availability. On good days, participants consumed three meals composed of rice, various vegetables, and protein foods (e.g., eggs, fish, chicken, pork, beef). These meals occasionally included fresh local fruit. On days where there were constraints to food access or availability, the quality of the diet declined. Participants generally consumed two rice meals and a sour soup made of vegetables and fish; fruit intake was rare on these days. The worst days were described as “hungry days”, where food quality and quantity were inadequate. One or two meals of low-quality rice would be consumed with either *prahok* (preserved, fermented fish paste) or a watered-down sour soup containing small amounts of vegetables and fish (31). These perpetual fluctuations in food intake put populations at risk of malnutrition.

2.3 Malnutrition

The World Health Organization (WHO) uses malnutrition as an umbrella term to capture deficiencies, excesses, or imbalances related to energy or nutrient intake (32). Undernutrition has historically been the central concern in low- and middle-income countries (LMICs), as it affected large portions of their populations and had severe, observable health consequences. For example, undernutrition is estimated to contribute to 45% of child deaths globally (33). Undernutrition is commonly monitored using anthropometric indicators such as wasting (low weight-for-height), stunting (low height-for-age), and underweight (low weight-for-age) (32). These indicators are generally applied to children, as child growth is universally recognized as an important proxy measure of a population’s nutritional and health status (34,35). Micronutrient deficiencies and insufficient energy intake (undernourishment) are other typical measures of undernutrition (36). Over the past two decades, overnutrition (e.g., overweight and obesity) has increasingly become

a concern in many LMICs (33,37). As a result, the double burden of malnutrition—the experience of both undernutrition and overnutrition within the same population or individuals—is present in many countries (38).

2.3.1 Malnutrition in Cambodia

Since 2000, Cambodia has seen significant improvements in the prevalence of stunting and underweight in children under five (39), yet levels of both conditions remain concerningly high. The 2014 CDHS reported stunting among 32% of children under five (22), with a lower risk of stunting in urban than rural children (odds ratio, OR [95% confidence interval, CI]: 0.59 [0.49-0.72]), and in children within the highest wealth quintile as compared to the lowest quintile (0.37 [0.29-0.48]) (39). One in four children were underweight, with rural and poor children again more commonly affected (39). Underweight was also reported within the adult female population, with 14% having a body mass index (BMI) $<18.5 \text{ kg/m}^2$ (22). No improvements were seen in the prevalence of wasting in children between the 2000 and 2014 CDHS (39). Wasting remains a “medium level” concern per the WHO classification (39), as 10% of the under-five population is affected by this condition (22). Wasting was more than two times as prevalent among children of underweight mothers, as compared to normal weight or overweight mothers (22). The prevalence of overweight or obesity in children has remained relatively stable ($<10\%$) (39), while it has been increasing among women of reproductive age (18% of the population) (22).

Anemia (measured as hemoglobin level $<110 \text{ g/L}$ in children and pregnant women, and hemoglobin $<120 \text{ g/L}$ in non-pregnant women) is a severe public health concern in Cambodia

across all age groups: 53% of children under five and 44% of women of reproductive age are anemic (22). There have been no significant improvements in the prevalence of anemia since the early 2000s (39). Anemia is known to increase the risk of maternal and child mortality (33,40). A meta-analysis by Black *et al.* demonstrated that in LMICs, an increase of 10 g/L in maternal hemoglobin in late pregnancy lowers the odds of maternal mortality by 29% (0.71 [0.60-0.85]) (33). Iron deficiency is the leading cause of anemia worldwide (41), and iron intake in Cambodia is relatively low (5,18,42). However, iron deficiency, along with deficiencies of vitamin A and vitamin B12—all essential nutrients for hemoglobin formation—are uncommon (22,39), suggesting that anemia in Cambodia may not be primarily of nutritional origin (41). Hemoglobinopathies (42) and hookworm infections (41) have been proposed as important causes of anemia. Micronutrient deficiencies in Cambodia will be described in more detail below.

Another form of malnutrition common in Cambodia is undernourishment. In the 2009 Cambodia *Socio-Economic Survey* ($n \approx 12,000$ households), one-third of the population was classified as undernourished because they did not meet the nationally determined minimum dietary energy requirement (MDER) of 1,770 calories per day (36). A smaller survey ($n=1,200$ households) conducted in 2011-12 found that only 25% of Cambodian households consumed the recommended daily calories (18). This study also used a nationally representative sample but did not provide an MDER reference (18). Another 2011 study focused on rural women ($n=67$), finding that only 17% of participants had a sufficient daily caloric intake (5). This study reported using an estimated average requirement (EAR) range for energy of 2,100-2,350 kcals/day (variation dependant on woman's age), but did not cite the source of this EAR (5). Overall, these data indicate persistent barriers to acquiring adequate quantities of food for large segments of the

population. It has been noted that the highest prevalence of food deprivation in Cambodia is present among women and those with the lowest levels of income (17).

2.3.2 Causes of malnutrition

The causes of malnutrition in Cambodia are multifaceted and complex. Insufficient food intake and disease are recognized globally as the immediate causes of malnutrition (43). As indicated above, many Cambodians do not consume a sufficient quantity or quality of food as a result of food insecurity (44,45) and poverty (23,44). An increased risk of disease is also present among the population, as one in five Cambodians does not have access to safely managed drinking water, and one in three does not have access to adequate sanitation facilities (13). As a result, parasitic diseases (e.g., hookworms) and other ailments that could lead to malnutrition are prevalent among the population (44). For instance, a 2017 study conducted among school-aged children in Battambang province (northwestern Cambodia) found parasites in the stool samples of half of all participants ($n=155$ of 308) (46)

Inadequate dietary diversity has also been advanced as an influential factor for malnutrition in Cambodia (39,47,48). Polished rice is relatively poor in micronutrients (e.g., thiamine, minerals) and fats, yet it comprises the majority of an individual's daily food intake (18,23). Families have limited access to varied foods as crop diversification among household farms is low, and the cost of acquiring such foods at the market is high (23). A 2017 analysis by the World Food Programme (WFP) indicated that women's dietary diversity is particularly low, which can affect the health of both women and their children during pregnancy and lactation (23). The WFP report highlighted green leafy vegetables, pulses, offal, blood, and fish as inexpensive and

available foods that could be added to the diet to increase its nutritional quality (23). However, some of these foods (i.e., pulses, offal, blood) do not align with a traditional Cambodian diet. Other foods (leafy greens, fish) are already incorporated into the diet whenever available to households.

A further factor associated with women's malnutrition is inequitable household food allocation, as influenced by the norms set in the *Chbab srei*, the traditional Khmer code of conduct for women (49). One of its principles focuses on dietary standards, stating that women should only begin eating a meal after the men in the household have been served (27). It is also customary for men to receive the highest quantity and quality of food in a meal (44,48). Additionally, women have been noted to preferentially feed their children over themselves in instances of food shortages (45). This practice was reflected in a 2019 qualitative study where focus group participants were asked to describe coping strategies used when faced with inadequate food resources (50). Participants described four different levels of strategies based on the severity of the situation. In the "somewhat severe" category (level two of four) was the strategy to "reduce the amount of food eaten by the wife in order for small children to eat" (50), demonstrating that women often sacrifice their own intakes in situations of household food scarcity. These cultural practices are of interest as inadequate maternal diet during pregnancy and lactation has been identified as an important contributor to malnutrition in children (23,51).

Barriers to maternal nutrition can also be related to a woman's participation in the workforce. In Cambodia, 81% of women of reproductive age are employed (8). The country's maternity leave entitles women to a 90-day leave with $\geq 50\%$ of their pay (52). Reductions in income can limit a

woman's financial access to foods during this critical period of her lifecycle. Additionally, the return to work three months postpartum makes it very challenging for women to follow the WHO recommendations of exclusive breastfeeding for the first six months of a child's life (53).

2.4 Dietary recommendations

Dietary recommendations are needed to guide individuals and populations towards nutritional intakes that minimize the incidence of malnutrition in all its forms and reduce the risk of noncommunicable diseases (e.g., cardiovascular disease). Countries or regions often develop their own dietary recommendations to ensure that they are tailored to their population's nutritional and health needs (54). This approach enables dietary recommendations to be constructed around characteristics like a region's dietary customs, food availability, and cultural context (55). Population-level dietary recommendations take two forms: food-based dietary guidelines and nutrient-based recommendations (e.g., dietary reference intakes, DRIs).

2.4.1 Food-based dietary guidelines

Food-based dietary guidelines aim to provide practical guidance to healthy populations on foods that should be prioritized or minimized in the diet (54). They translate the technical components of nutritional science (e.g., human nutrient needs, food composition) to general food-based recommendations for the population of interest (56). This focus on foods rather than nutrients enables individuals with minimal nutrition knowledge to use these guidelines. Food-based dietary guidelines are also often represented pictorially through food guides (54), making them accessible to segments of the population with low literacy levels. Many food-based guidelines

provide recommendations for specific subpopulations such as children and pregnant and lactating women (54).

2.4.2 Nutrient-based recommendations

Nutrient-based recommendations aim to provide quantitative estimates of the requirements for nutrients within healthy populations (57). These estimates are specific to a population's sex and lifecycle stage (56). Terminology used for nutrient-based recommendations varies by country. Canada and the United States jointly developed the DRIs, which include six different reference standards, described in **Table 2-1** (57,58).

Table 2-1. Description of dietary reference intakes (57,58).

| Reference | Description |
|-----------|--|
| EAR | Estimated Average Requirement: Usual daily intake estimated to meet the requirements of 50% of healthy individuals. |
| RDA | Recommended Dietary Allowance: Usual daily intake expected to meet the requirements of 97-98% of healthy individuals. The RDA is statistically derived as 2 SD above the EAR. |
| AI | Adequate Intake: Average daily intake of an apparently healthy population. The AI is used when there is insufficient evidence to determine an EAR. |
| UL | Tolerable Upper Intake Level: Highest usual daily intake that is unlikely to pose a risk of adverse health effects for nearly all healthy individuals. |
| AMDR | Acceptable Macronutrient Distribution Range: Usual intake that has been associated with a lower risk of noncommunicable disease and that provides an adequate intake of essential nutrients. |
| EER | Estimated Energy Requirement: Level of energy intake that is estimated to maintain energy balance. This calculation is based on weight, height, physiological state, and energy expenditure. |

The RDA is referred to as the recommended nutrient intake (RNI) in various international settings; this is the term used by the WHO and FAO (59). Values for RDAs/RNIs vary slightly between countries or regions (60). These variations reflect differences in usual diet patterns, bioavailability of nutrients within the typical diet (e.g., intake of antinutrients), ethnicity, lifestyle, prevalence of disease, and the average body weight of a country's citizens (since requirements for many nutrients are based on a reference body weight) (61). Differences in a country's climate and geographic location will also affect nutrient needs (61) (e.g., sunlight exposure and latitude affect dietary requirements for vitamin D (62), while altitude can affect iron requirements (63)). Substantial scientific judgment is needed to develop the best-suited recommendations to support the health of a population.

2.5 Nutrition during pregnancy and lactation

Pregnancy and lactation are periods of the lifecycle in which nutritional requirements are particularly high, placing women at increased risk of malnutrition (64). Insufficient intake of energy, macronutrients, or micronutrients can result in severe and permanent health outcomes for both mother and child. Women who are malnourished during pregnancy are at a higher risk of mortality (65,67) and fetal loss (51,65), and more likely to have a newborn with a low birth weight (LBW; < 2500g) (35,48,65,67). LBW has been associated with multiple adverse outcomes in children, including higher risks of stunting, wasting, underweight (68,69), impaired cognitive and motor development (65,67,70,71), metabolic disease (65), and mortality (35,65,67). A review of 19 longitudinal birth cohorts in LMICs found LBW to be associated with 2.5-3.5 higher odds of wasting, stunting, and underweight in children under five (69).

Maternal nutrition remains important during lactation: insufficient dietary intake can adversely affect the concentrations of multiple micronutrients in breastmilk essential to infant development and maternal health (51,72). For instance, the concentration of thiamine, riboflavin, iodine, and vitamins A, B6, and B12 in breastmilk are directly affected by maternal intake or stores of these micronutrients (73). If dietary intake is inadequate, mothers and their infants can become depleted of essential micronutrients (74), again resulting in potentially lifelong adverse outcomes (e.g., vitamin B12 deficiency and irreversible impaired cognitive development). The increased nutrition needs during pregnancy and lactation are represented in many population-level nutrition guidelines.

2.5.1 Dietary recommendations in Cambodia

Peripartum nutrition guidelines from the Cambodian government follow a food-based approach. There is no Cambodian food guide for adults, but dietary recommendations are shared with women through healthcare professionals at local health centers. The *Minimum Package of Activities Curricula for Health Centres—Module 10 Nutrition* (also referred to as MPA Module 10) is used as a training tool for health center staff (75). The MPA Module 10 was first developed in 1998; the latest revision was released in 2009. This tool aims to strengthen the nutritional knowledge of healthcare professionals and improve the provision of nutrition-based interventions for women and children. It directs staff to provide specific nutrition messages to women during their peripartum visits (details below) (75). In 2019, the Ministry of Health released the *Guideline for Implementation of the Service Package of Antenatal Care, Delivery, and Postnatal Care*, a further guide for health center staff working in maternal and child health

(76). Nutrition-related messages reiterate those included in the MPA Module 10, and provide additional guidance related to food groups that women should include in their diet (76).

During pregnancy and lactation, women in Cambodia are counseled by healthcare professionals to have four meals daily consisting of foods from three food groups: “body-building foods” (e.g., fish, eggs, liver, meat, tofu, soy milk), “energy foods” (e.g., rice, noodles, maize, yam, taro), and “protective foods” (e.g., green leafy vegetables such as morning glory, and yellow/orange fruits and vegetables like sweet potato and mango) (76). Women are encouraged to avoid sugary and packaged foods, and recommended to use iodized salt (75,76). Fortification of salt with iodine is mandatory in Cambodia, yet use of iodized salt is far from universal: the 2014 CDHS found 82% of urban households had iodized salt, while this occurred in only 67% of rural households (22). The low use of iodized salt may be explained by the inadequate provision of iodine premix by international organizations to the salt industry, and insufficient government enforcement of salt fortification (77).

In addition to dietary modifications, women are advised to consume daily iron/folic acid tablets containing 60 mg iron and 400 µg folic acid (75,76). These tablets are taken for 90 days during pregnancy (starting at first antenatal visit) and for 42 days postpartum. Iron and folic acid supplements are provided to women during their peripartum visits at local health centers (75,76). Nearly 94% of women in Cambodia take iron/folic acid tablets during pregnancy, with 76% of women taking the full regimen of 90 tablets (22). Adherence to iron supplementation treatments during pregnancy in LMICs benefits both maternal and infant health: daily supplementation (as

compared to no supplementation) has been associated with a 47% (0.53 [0.35-0.57]) reduction in the risk of anemia in women and a 12% (0.88 [0.01-0.22]) reduction in the risk of LBW (78).

Cambodia has not established DRIs for its general population, although, in 2017, a set of RDAs for school-aged children in Cambodia was developed (79). The most relevant micronutrient recommendations for pregnant and lactating women are the Southeast Asian RDAs (SEA-RDA) (60). These recommendations highlight the importance of increasing maternal nutritional intake during pregnancy and lactation. Of the 12 essential vitamins and minerals included in the SEA-RDAs, higher requirements are noted for 11 nutrients. The only nutrient that does not need to be increased during pregnancy and lactation, according to the SEA-RDA, is vitamin D; this may be related to changes in vitamin D metabolism during this period (80). The SEA-RDAs also recommend an increase in daily caloric and protein intake (see **Table 2-2**) (60). Other relevant macronutrient recommendations can be obtained from the WHO's AMDR. These indicate that the general population should aim to consume 10-15% of energy intake from protein, 15-30% from fat, and 55-75% from carbohydrates (81). For women of reproductive age, a minimum fat intake of 20% of daily calories should be targeted (81). The WHO does not specifically provide an AMDR for pregnant and lactating women, but the joint Canadian-American DRIs indicate that macronutrient reference ranges remain unchanged during this period of the lifecycle (82).

Table 2-2. SEA-RDAs for women of reproductive age. Adapted from (60).

| Nutrient | Recommended Dietary Allowance | | | | | |
|--|--------------------------------------|--------------------------------|--------------------------------|--------------------------------|-------------------------------------|------------|
| | Preconception^a | Pregnancy | | | Lactation | |
| | | Trimester 1 | Trimester 2 | Trimester 3 | Month 1-6 | Month 7-12 |
| Calcium (mg/day) | 700 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Iron (mg/day, assuming 7.5% bioavailability) | 39.2 | 39.2 + supplement [*] | 39.2 + supplement [*] | 39.2 + supplement [*] | 20.0 | 20.0 |
| Zinc (mg/day, assuming 'moderate' bioavailability) | 4.4 | 5.5 | 7.0 | 10.0 | 9.5 ^b , 8.8 ^c | 7.2 |
| Iodine (µg/day) | 150 | 200 | 200 | 200 | 200 | 200 |
| Selenium (mg/day) | 26 | 26 | 28 | 30 | 35 | 42 |
| Vitamin A (µg/day) | 500 | 800 | 800 | 800 | 850 | 850 |
| Vitamin C (mg/day) | 70 | 80 | 80 | 80 | 95 | 95 |
| Vitamin D (µg/day) | 5 | 5 | 5 | 5 | 5 | 5 |
| Thiamine (mg/day) | 1.1 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 |
| Riboflavin (mg/day) | 1.1 | 1.4 | 1.4 | 1.4 | 1.6 | 1.6 |
| Niacin (mg/day) | 14 | 18 | 18 | 18 | 17 | 17 |
| Folate (µg/day) | 400 | 600 | 600 | 600 | 500 | 500 |
| Protein (g, assuming 80% protein quality) | 50 | +7.5 | +7.5 | +7.5 | +20 | +15 |
| Energy (kcal/day) | 2,115 | - | +360 | +475 | +505 | +675 |

^a Values for age 19-29 years^b 0-3 months postpartum^c 4-6 months postpartum^{*} Iron supplements recommended for all pregnant women; supplement dose varies between anemic and nonanemic women

Given the array of factors explored above that affect a woman's food intake, it is conceivable that pregnant and lactating women would have difficulties increasing the quantity of food consumed and improving the nutritional quality of their diet.

2.5.2 *Macronutrients of interest in Cambodia*

The Cambodian diet is characteristically low in fat (14% of total energy), moderately low in protein (10% of total energy), and high in carbohydrates (76% of total energy) (67). This dietary

pattern falls below the WHO AMDRs for fat and is at the lowest recommended range for protein. This is of concern as adequate fat and protein intake is vital for a healthy pregnancy. Essential fatty acids such as alpha-linolenic acid (ALA) are necessary for fetal brain and retinal development (83). Proteins play an equally important role as they support the rapid growth of maternal, placental, and fetal tissues. Over one-third of the protein in a Cambodian diet is plant-based (18). This form of protein has a lower biological value than animal-based protein, increasing the amount needed to meet physiological requirements (77). Insufficient protein consumption or deficiencies in specific amino acids during pregnancy can lead to embryonic losses, *in utero* growth restrictions, preterm birth (84), and can adversely affect the body composition of offspring (85).

A woman's nutritional status does not greatly impact the overall macronutrient composition of her breastmilk (72). For example, maternal protein intake during lactation does not affect the concentration of protein in breastmilk (72). The fatty acid profile of breastmilk does vary according to maternal intake (73,86). Previous work has demonstrated that levels of eicosapentaenoic (EPA) and docosahexaenoic (DHA) fatty acids in human milk are directly influenced by maternal intake of these nutrients (86). Therefore, a high intake of fish can positively influence breastmilk quality. The composition and volume of breastmilk are adversely affected only in instances of severe maternal undernutrition (51).

2.5.3 Micronutrients of interest in Cambodia

While micronutrient requirements increase during pregnancy and lactation, evidence suggests that many women fall short of these needs. A 2019 study used dietary modeling based on a

typical diet of pregnant Cambodians to identify ‘problem nutrients’, that is, micronutrients consumed in insufficient quantities to meet nutritional needs (87). Based on diet alone, six problem nutrients were found: iron, vitamin A, calcium, thiamine, riboflavin, and folate (87). As noted previously, iron and vitamin A deficiencies are not common in Cambodia, which may be related to the national supplementation program for both nutrients (22). While calcium intakes are low, absorption of this mineral more than doubles by 12 weeks pregnancy, which helps meet increased demand (80). Biochemical evidence of thiamine (88), riboflavin (89), and folate deficiencies (22) is prevalent among women in Cambodia, as are deficiencies of zinc (41,77), iodine, and vitamin D (22). These nutrients all play a critical role during pregnancy and lactation, therefore warranting further examination.

Dietary sources of thiamine, riboflavin, folate, zinc, iodine, and vitamin D can be limited within the Cambodian diet. Polished rice, the main dietary component, has been stripped of its husk and bran, thereby eliminating most of its thiamine and riboflavin (89). Polished rice is also a poor source of folate, zinc (90), and iodine (91) and provides no vitamin D (90). Important sources of thiamine available in Cambodia include pork, mung beans, and peanuts (90). Riboflavin-rich foods include freshwater river shrimp, black paddy crab, gunthers walking catfish, and mushrooms, while folate-rich foods include mung beans, peanuts, and flowering white cabbage (90). Zinc is found in higher concentrations in fermented soybean, black paddy crab, pork, and whole grain maize (90). Good sources of iodine are fish and iodized salt (92), and good sources of vitamin D include Siamese mud carp, common silver barb, catfish (gunthers walking and striped), and short-bodied mackerel (see **Table 2-3**). The typical intake of many foods listed above are too low to meet the SEA-RDA for key micronutrients (17,93).

Table 2-3. Nutrient composition of select foods in Cambodia. Adapted from (90).

| Food | Zinc (mg) | Vitamin D (µg) | Thiamine (mg) | Riboflavin (mg) | Folate (µg) |
|--------------------------------|-----------|----------------|---------------|-----------------|-------------|
| Mung bean, dry, raw | 2.7 | 0 | 0.73 | 0.23 | 625 |
| Peanut, whole skin | 2.07 | 0 | 1.1 | 0.17 | 240 |
| Maize, white, whole grain, raw | 2.74 | 0 | 0.30 | 0.16 | 26 |
| Mushroom | 0.54 | 1.9 | 0.1 | 0.44 | 25 |
| Flowering white cabbage | 0.63 | 0 | 0.07 | 0.16 | 187 |
| Pork meat, lean, raw | 2.25 | 69 | 0.9 | 0.21 | 5 |
| Freshwater river shrimp | 0.97 | 2 | 0.07 | 0.72 | 25 |
| Mackerel, short-bodied, raw | 0.6 | 292 | 0.11 | 0.24 | 1 |
| Striped catfish, raw | 1.6 | 500 | 0.02 | 0.19 | 10 |
| Common silver barb, raw | 0.1 | 988 | 0.02 | 0.06 | 15 |
| Catfish, gunthers walking, raw | 0.2 | 500 | 0.01 | 0.45 | 10 |
| Black paddy crab, raw | 4.3 | 0 | 0.01 | 0.51 | 44 |
| Fish, Siamese mud carp, raw | 1.53 | 988 | 0.02 | 0.06 | 15 |
| Soybean, fermented | 4.89 | 0 | 0 | 0.12 | 4 |

Note: Nutrients are expressed as content per 100 g edible portion, and data is only available for the raw format of foods. No values for iodine are provided as these are not available in the food composition table for Cambodia (90) or for the Association of Southeast Asian Nations (94).

In 2014, the *Cambodian Micronutrient Survey* (CMNS-2014) was conducted to assess the micronutrient status of mothers aged 15-49 years and children under six years of age (22,41).

The CMNS-2014 used a nationally representative sample from one-sixth of the clusters involved in the 2014 CDHS (22). Samples of venous blood, urine, and stool were collected (22). An analysis of data from the CMNS-2014 revealed that thiamine deficiency was prevalent in Cambodia: 27% of women and 15% of children were considered thiamine deficient when a conservative cut-off of <120 nmol/L erythrocyte thiamine diphosphate (eThDP) concentration

was applied (88). Thiamine is required for energy metabolism, nerve impulse conduction (95), and muscle function, and plays a key role in fetal neurological and cognitive development (85). Thiamine deficiency during pregnancy can bring on anorexia, neurological symptoms, and intrauterine growth restrictions (85). Maternal deficiency during lactation can put the infant at risk of developing infantile beriberi, a condition that is often fatal (89). In less severe forms of thiamine deficiency, infants can experience impaired cognitive development and functioning, cardiac failure, seizures, and speech impairments (96).

Riboflavin was demonstrated to be a micronutrient of concern for Cambodian women in two recent studies (89,97). Deficient or suboptimal riboflavin status (erythrocyte glutathione reductase activity coefficient ratio, EGRac, ≥ 1.3) was found in approximately 90% of women within a population-representative sample ($n=302$) from an urban and rural region in Cambodia (89). A second study among women ($n=515$) in two rural Cambodian provinces had similar findings, with 83% of women being riboflavin deficient (EGRac ≥ 1.4) (97). Riboflavin is a cofactor involved in various metabolic activities (e.g., metabolism of proteins, fatty acids, B-vitamins) and heme synthesis (85). Riboflavin deficiency has been associated with growth retardation, congenital heart abnormalities (89), and preterm birth (85). The concentration of both thiamine and riboflavin in breastmilk is positively associated with maternal intake of these vitamins (73).

Additional analyses of the CMNS-2014 revealed that 18% of women had low serum folate concentration (<10 nmol/L) (22,41), 63% had zinc deficiency (<9.9 μ mol/L) (41), and 78% were iodine-deficient (urine concentration <100 μ g/L) (22). Folate is necessary for periods of rapid

growth and development as it is implicated in functions such as cell replication, cell division, and nucleotide synthesis (98). Inadequate maternal intake of folic acid during pregnancy has been associated with neural tube defects in offspring (98); during lactation, inadequate folate intake presents a higher risk to maternal health, as folate is preferentially secreted into breastmilk (73). Zinc is critical for embryogenesis (99), organogenesis, and overall growth and development (100). Studies have demonstrated inconsistent associations between zinc status and pregnancy outcomes, but there appears to be growing evidence that inadequate zinc status can increase the risk of LBW (85,99). For example, in Tanzania, maternal low zinc status at delivery (as compared to normal zinc status) was associated with a 2.5 times higher risk of giving birth to an infant that weighed $\leq 2000\text{g}$ (2.62 [1.36-5.73]) (101). Iodine, a component of thyroid hormones, is involved in growth regulation, cellular metabolism, and the development of the brain and nervous system (85). During pregnancy, mild maternal iodine deficiency can impair fetal growth, cognitive and motor development, and increase the risk of miscarriage (51,85). Maternal iodine deficiency during lactation has been associated with significant reductions in infant intelligence quotient (51,85).

Finally, the CMNS-2014 found that 29% of women who had children under the age of five were deficient in vitamin D (25-hydroxyvitamin D serum levels $\leq 50\text{ nmol/L}$) (102). This finding is surprising due to the country's proximity to the equator, but can be explained by various lifestyle habits that limit sun exposure, including increased prevalence of indoor work (e.g., in factories) (102) and sun-protection behaviours (e.g., wearing hats and long sleeved-shirts) (103). Vitamin D is an essential component of bone metabolism as it promotes intestinal calcium absorption (98). Adequate vitamin D status is particularly important during pregnancy and lactation, when

skeletal structures are developing (85). Deficiency of vitamin D during pregnancy can lead to restricted fetal growth and bone mineralization (51), as well as rickets, soft cranial bones, and osteopenia (85). The level of total vitamin D in breastmilk is positively correlated with maternal intake of vitamin D (73).

The above examples clearly illustrate the importance of ensuring adequate maternal nutrition during pregnancy and lactation for the health of both mothers and children, while also indicating that multiple micronutrient deficiencies are prevalent within the same population of women in Cambodia. There is growing evidence that many Cambodian women's diets do not meet their needs during the peripartum period, due in part to traditional peripartum practices (23,48).

2.6 Cambodian peripartum culture

Within Cambodian culture, pregnancy is recognized as a potentially risky period in a woman's life. The Khmer expression *chlong tonlee*, crossing the river, is commonly used to refer to childbirth, as both undertakings can be dangerous (6). The risk of pregnancy is reflected in the country's maternal mortality rates: approximately 170 of every 100,000 pregnancies result in maternal death (22). Maternal mortality has been in decline over the past two decades, which may be attributed in part to a government campaign to increase the access to, and quality of, peripartum care (22). During the 2008-2013 period, 95% of Cambodian women received antenatal care at least once from a trained professional (i.e., a doctor, nurse, or midwife), with 89% of women being assisted at delivery from a member of one of these professions (22). Midwives have been noted as important influencers during the peripartum period (3,104), as they

often bridge the biomedical approaches to health used by medical professionals and the cultural beliefs held by many Cambodian women (104).

The Ministry of Health reports that 40-50% of Cambodians use traditional medicines on a regular basis (104). The Cambodian government actively tries to diminish this practice during pregnancy and lactation. For instance, during peripartum visits, healthcare professionals are trained to advise women against taking traditional medicines and discuss the risks of such practices with women (76). Cambodian traditional medicine is similar to that practiced in China and Vietnam in that it is based around humoral theory, wherein health status is believed to be influenced by the body's balance of 'hot' and 'cold' (3,104,106). Pregnancy is viewed as a hot state, while postpartum is a cold state (3). Common peripartum practices aim to support and protect the woman during these periods of imbalance; these practices also appear to be rooted in the gestational experiences of multiple generations of women.

2.6.1 Pregnancy customs

There is scant literature describing pregnancy practices within Cambodia. A 2011 study in the southwest province of Krong Kep found that certain foods may be added to the maternal diet with the goal of improving pregnancy outcomes for both mother and baby (3). For instance, coconut water directly from the coconut was believed to benefit the baby's skin and support an easy delivery. Other desirable foods during pregnancy were sour foods, sweets, ice water, and durian fruit, but no context was provided to describe the reasons for the desirability of these foods (3). Rice wine was used as a traditional medicine to help maintain a woman's strength during pregnancy (3). In a study in the northwest province of Siem Reap, women reported an

increased intake of sweet foods (to help with appetite and energy) and salt (107). This study also found that white meat and coconut milk were desirable foods, as they were believed to give the baby a lighter skin tone (107). It is also common across the country for women to report concerns around having a large baby and experiencing delivery complications (48,108,109). One study found these fears to be more prevalent among primiparas, as they were unfamiliar with the birthing experience (108). Women coped with childbirth concerns by limiting the type and quantity of food consumed and following the traditional practice of eating meals quickly, which is said to help ensure a quick delivery (48).

2.6.2 *Postpartum customs*

Immediately after birth, Khmer traditions aim to restore heat to a woman's body, as she is considered to be weak and vulnerable during this period (106). Failing to restore heat is believed to bring upon physical and psychological illness, referred to as *toa* (sometimes written as *tos* or *toas*) (104,110). Symptoms of *toa* are variable, including seizures, collapse, 'madness' (110), diarrhea, abdominal pains (6,110), headaches, and poor appetite (6); some forms are said to persist throughout the remainder of the woman's life (110). *Toa* is also commonly reported to result from eating the wrong foods or overworking after childbirth (6).

An approach used in multiple Southeast Asian countries to help women restore heat lost during the birthing process is *ang pleung*, or 'roasting' (6). During *ang pleung*, a woman lies on a bed set over a fire for three to seven consecutive days (106). It is believed that this practice has many benefits, including heating the bones and tendons, preventing uterine blood clotting, and rejuvenating energy (3). *Ang pleung*, a once-ubiquitous practice, has been described as outdated

by younger generations of Cambodians (104). It is also now discouraged by many healthcare practitioners due to the risks to the mother and infant (104). While the mother is roasting, she generally does not breastfeed her baby, causing a delay in breastfeeding initiation (106,111). It has been reported that traditional birth attendants specifically advise women not to breastfeed during their first few days postpartum to avoid disrupting traditional practices (111). Women living in urban areas practice *ang pleung* less commonly than those in rural settings for multiple reasons, including the cost of, and access to, fuel for the fire (106). Despite these differing views of *ang pleung* and its barriers, a 2011 study with women ($n=115$) from 16 villages in Krong Kep, Cambodia found that 69% of women engaged in this traditional practice (3).

Postpartum heating is seen as a necessity in Cambodian culture (106); therefore, women who do not practice *ang pleung* use alternative heating methods such as placing hot stones on their abdomen or receiving ‘heat injections’ (3). These injections usually contain antibiotics, vitamins, or pain medications (3,109), and are given at minimum twice daily for up to two weeks postpartum (104). The popularity of heat injections is increasing in Cambodia, as are concerns about the risks of blood-borne infections contracted through inadequate injection practices (104).

Within traditional Cambodian practices, diet is also considered important during the postpartum period. A variety of foods and beverages have been reported as being preferentially added to the diet, including pepper-braised beef, pork, and fish, spicy foods, salty foods (3,104,106), homemade wine, and herb-based tonics (104,107). These items are thought to help improve health and general bodily function, promote appetite, and increase breastmilk production (104). A 1995 study reported that during *ang pleung*, women are encouraged to consume the widest

variety of foods possible to prevent *toa* (6); however, this finding does not appear to have been corroborated by any subsequent studies. Along with specific food additions, an extensive list of foods to be avoided during the peripartum period also exists, described more below.

2.7 Food taboos

Food taboos are avoidances that go beyond personal tastes or preferences; they are culturally-specific rules or customs that prohibit certain food choices and are transmitted throughout generations by elders, leaders, and other power-holders within communities (112). Food taboos are present in societies across the globe (1). They are particularly prevalent throughout pregnancy and lactation as a means of protecting the health of women and children (1,2). Two systematic reviews in 2018-19 explored the various peripartum food taboos practiced in Southeast Asia (2,4). These reviews highlighted a wide variety of maternal food avoidances, including river food, seafood, meats, eggs (2), water spinach, cabbage, fresh fruit, and multiple vegetables (4). There were more food taboos practiced during the postpartum period than in pregnancy (2). Foods that were avoided were believed to cause harm to the mother or baby through means such as difficult delivery, gastrointestinal disorders, hemorrhage, loss of consciousness, and death (2).

2.7.1 Food taboos in Cambodia

Few studies have assessed food taboos in Cambodia; amongst the ones that have, the following foods have been identified as needing to be avoided during pregnancy: spicy foods (5,107), salty foods (e.g., fermented fish paste *prahok*) (5), coconut milk, porridge (3), oily foods, black/burnt rice (107), and any foods that are considered ‘hot’ according to humoral theory (e.g., meats,

sweets, coffee, spices) (3,107). Postpartum, salty foods (5), specific types of fish (kry, kahel, broma, khgoeng), certain banana varieties (5,6), pineapple, jackfruit, field cucumbers, buffalo meat, and pig's head (6) have all been identified as taboo. Foods not consumed during *ang pleung* may also be categorized as taboo, as they are believed to result in *toa* (6).

Most foods listed above came from relatively small-scale studies conducted in different regions of Cambodia ($n=67$ in southern Kandal province (5); $n=115$ in coastal Krong Kep (3); and $n=129$ in Phnom Penh and three rural provinces in the Tonlé Sap region (6,106)). Other taboos were reported as a result of fieldwork observations in northwest Siem Reap combined with data on practices of Cambodian refugees who have settled abroad (107). Notably, a second and more recent study in Siem Reap found no commonly practiced food restrictions during pregnancy among their sample of women ($n=58$) (110). However, the authors did not define the term 'food restriction', making it unclear if this term is meant to represent food taboos. Healthcare professionals are specifically trained by the Cambodian government to discourage women from adhering to maternal food taboos (75,76). Peripartum food taboos need to be further explored to better understand the nutritional context of pregnant and lactating women in Cambodia.

2.7.2 Potential health implications

Given the higher nutritional needs during pregnancy and lactation, any restriction to the quantity and quality of food consumed by a woman can make her and her child vulnerable to undernutrition and micronutrient deficiencies. Additionally, food taboos can reduce dietary diversity, a factor known to be associated with malnutrition (2). Many of the avoided foods identified in Cambodia are animal-based, which increases the risk of insufficient intake for

numerous essential nutrients with high bioavailability. Restricting the consumption of fish, for example, would limit a woman's intake of high-quality protein, alpha-linolenic acid, iron, zinc, vitamin D, riboflavin, and other micronutrients. As demonstrated above, inadequate maternal nutrition during the critical periods of pregnancy and lactation can result in adverse health outcomes such as LBW, preterm birth, impaired fetal development, and mortality.

2.8 Research gap and study purpose

The breadth and impact of food taboos in Cambodia have not been thoroughly explored. It is unclear whether all aforementioned food restrictions are followed together, what proportion of the population adheres to them, and whether there are differences in adherence based on characteristics such as age, education, or income. It is also unknown whether women who engage in food avoidances also intentionally add foods to their diet during pregnancy and lactation, potentially counterbalancing the nutritional impact of food taboos. As such, the purpose of this study was to explore maternal food taboos and food additions during pregnancy and lactation in Cambodia.

3.0 Methods

3.1 Study objectives

The study objectives are as follows:

- 1) Describe foods that are intentionally avoided and added to the maternal diet during pregnancy and lactation in Kampong Thom, Cambodia, along with reasons for these dietary modifications.
- 2) Determine whether these dietary modifications align with the Cambodian government's maternal dietary recommendations, as outlined in the *MPA Module 10* and the *Service Package for Antenatal, Delivery, and Postnatal Care guidelines*.
- 3) Identify sociodemographic and health predictors of food taboos and food additions.

3.2 Study design

This research project was a mixed-method, secondary analysis of data collected as part of the *Trial of Thiamine Supplementation in Cambodia* between September 2018 and May 2019 (95).

The overarching study was designed to formulate thiamine-fortified salt to combat thiamine deficiency in Cambodia: this community-based, four-parallel arm randomized control trial was performed to estimate the oral thiamine dose needed to optimize thiamine concentration in human milk. As part of the larger study, open-ended data were collected on the dietary practices of women during pregnancy and lactation (95).

3.3 Study setting

The study took place in the central Cambodian province of Kampong Thom. Many women living in this rural province are employed as agricultural workers (64% of female workforce) and have

a lower level of education than other parts of the country (median education of 3.7 years, as compared to 4.8 years for the rest of the country) (22). Kampong Thom residents engage in optimal health behaviours: 96% of mothers initiate breastfeeding, 96% receive antenatal care from a skilled healthcare provider (i.e., doctor, nurse, or midwife), and 86% of households have iodized salt (vs. the national total of 69%). Despite these positive actions, Kampong Thom province has the second-highest perinatal mortality rate in Cambodia, with 29 deaths per 1,000 pregnancies (compared to the national rate of 20 deaths per 1,000 pregnancies) (22).

3.4 Participants

3.4.1 Sampling methods

Recruitment for the larger study occurred through antenatal care visits and consultations with local village chiefs, staff from health centers, and elders (95). The contact information of women who were interested in participating in the study was provided to the research team. After delivery, the research team followed up with women to ensure they met eligibility criteria (described below), then obtained informed consent and enrolled women into the study. Recruitment was conducted on a rolling basis between August and December, 2018.

3.4.2 Sample size

This was an exploratory, secondary analysis of data already collected. The study's sample size at two-weeks postpartum was $n=335$ (more details on sample size calculation for the larger trial can be found in Whitfield *et al.* (95)). At 12 weeks postpartum, $n=310$ (attrition of 7%), while at 24 weeks postpartum, $n=298$ (attrition of 11% from initial sample).

3.4.3 Eligibility criteria

Study participants were lactating women living in the catchment areas for the following eight health centers in Kampong Thom: Tboung Kapoeur, Kampong Svay, Sankor, Chey, Salavisai, Prey Kuy, Prey Pros, and Srayov. Women were eligible to participate in the study if they were the mother of a newborn, aged 18-45 years, and had a normal pregnancy (i.e., no known chronic conditions, preeclampsia, gestational diabetes, etc. for their most recent pregnancy) with a singleton infant born without complications (e.g., no LBW, tongue tie, cleft palate).

Additionally, participants had to intend to exclusively breastfeed for six months, not be planning on moving within six months of study recruitment, and not be participating in nutrition programs (beyond normal care). Of relevance to the larger study, participants were eligible if they had not taken any thiamine-containing supplements four months prior to study recruitment, and were willing to consume one capsule daily from two to 24 weeks postpartum and have her entire household consume only salt provided by the study team. Finally, participants had to be willing for the following biological samples to be collected: a maternal venous blood sample and human milk sample at two weeks postpartum; a human milk sample at four and 12 weeks postpartum; and maternal and infant blood samples and a human milk sample at twenty-four weeks postpartum (95).

3.4.4 Remuneration

Study participants received a mobile cell phone, along with mobile phone credits. This facilitated communication between study participants and the research team. Participants were also gifted a sarong and laundry soap (value of 3 USD) at each study visit.

3.5 Ethical considerations

The overarching study received ethics approval from the National Ethics Committee for Health Research in Cambodia (112/250NECHR) and the Mount Saint Vincent University Research Ethics Board in Canada (2017-141) (see **Appendix A and B**). All data used in this secondary analysis were deidentified. All participants provided written informed consent to participate in the study (see **Appendix C**).

3.6 Data collection

Data were collected in participants' homes using interviewer-administered tablet-based questionnaires (Open Data Kit Collect Version 1.22.4 software on a Samsung Galaxy tablet) at two, 12, and 24 weeks postpartum (95). During the two-week postpartum visit, data were collected on maternal dietary modifications during pregnancy and postpartum (see **Appendix D**). During the 12- and 24-week postpartum visits, dietary questions were focused solely on the period since the participant's last interview with the research team (e.g., questions during the 12-week postpartum visit focused on the changes that occurred in the previous ten weeks). At each timepoint, participants were asked if there were any foods/drinks they avoided during pregnancy/postpartum as well as if there were any foods/drinks they specifically chose to eat/drink during pregnancy/postpartum. Participants who answered 'yes' to either question were asked to list the foods/drinks they chose to avoid/add to their diet, and to explain the reason for each dietary modification.

Multiple sociodemographic and health characteristics were collected at the two weeks postpartum visit. Characteristics of interest for this analysis were participant age (years),

maternal education, number of pregnancies, number of live births, number of antenatal care visits attended, annual household income (USD), and relative wealth (measured in quintiles using EquityTool survey for Cambodia (113)). The EquityTool is a short survey that assesses a household's relative wealth based on various household characteristics relevant to the country's specific context. The EquityTool survey for Cambodia is composed of 14 questions, including items such as source of drinking water, type of flooring in household, and ownership of a motorcycle/scooter (113).

3.7 Data analysis

Descriptive statistics were computed for participant characteristics and dietary modifications and presented as n (%) for categorical variables and mean (standard deviation, SD) for continuous variables. Shapiro-Wilk test was applied to assess the normality of data distribution (114); data with non-normal distributions were presented as median (interquartile range, IQR). IBM SPSS v. 26.0 for Windows (IBM Corp, 2018) was used to perform quantitative data analyses, with a significance level of $p < 0.05$ being used for all significance tests. MAXQDA v. 20.4.0 for Windows (VERBI Software, 2019) was used for qualitative analysis.

3.7.1 Objective 1: Describing dietary modifications

The incidence of food avoidances and food additions in the maternal diet was described at each study timepoint (pregnancy, zero to two weeks postpartum, two to 12 weeks postpartum, and 12 to 24 weeks postpartum). The number of unique foods avoided and added by the study sample was presented for each peripartum period, as was the median number (IQR, range) of unique foods individual women avoided or added to their diet. Friedman's test was performed to

determine if there were differences in the number of foods individual women avoided or added in their diet by peripartum period. Wilcoxon signed-ranks tests with Bonferroni correction were used for multiple comparisons when tests revealed statistically significant differences (115).

The five most commonly avoided and added foods at each peripartum period were reported with the number of women (*n*, %) avoiding/adding each specific food. To better illustrate the types of foods eliminated or added to the maternal diet, foods were categorized using the minimum dietary diversity for women (MDD-W), a validated indicator for assessing population-level dietary diversity among women of reproductive age (116). This dichotomous indicator is used to represent whether women consumed foods from ten basic food groups: grains, roots, and tubers; pulses; nuts and seeds; dairy; meat, poultry, and fish; eggs; dark leafy greens and vegetables; other vitamin A-rich fruits and vegetables; other vegetables; and other fruits (116). All optional categories of the MDD-W assessment were also used in this study: condiments and seasonings; other beverages and foods; insects and other small protein foods; red palm oil; other oils and fats; savoury and fried snacks; sweets; and sugar-sweetened beverages. Ingredients in mixed dishes were coded individually (116). For this study, the number of unique foods (*n*, %) avoided or added per food group was presented for pregnancy and postpartum. The category ‘condiments and seasonings’ was only used when items falling into that category were specifically reported by women (e.g., chili peppers were categorized as a condiments/seasoning, but soups were not).

Content analysis was employed to describe women’s rationales for adhering to food taboos or food additions during pregnancy and postpartum (117,118). An inductive approach was used for coding to allow for codes to be derived directly from the dataset. These codes were subsequently

organized into larger categories that represented the perspectives and beliefs of study participants (119,120). For each of the three most commonly avoided and added foods during pregnancy and postpartum, all reasons for avoidance/addition provided by participants were presented.

3.7.2 Objective 2: Determining if modifications align with government recommendations

The Ministry of Health aims to support maternal and child health by promoting necessary peripartum dietary modifications. They advise women to add the following foods to their diet: body-building foods (e.g., animal products), energy foods (e.g., rice, maize, fats), and protective foods (e.g., fruits and vegetables) (75,76). They also recommend that women avoid sugary or packaged foods.

To assess whether women adhere to these dietary recommendations, each food eliminated or added to the diet by women in the study sample was coded as ‘meeting’ or ‘opposing’ government recommendations. Food avoidances were coded as ‘meeting’ recommendations if a woman eliminated sugary foods or packaged foods. Avoidances were coded as ‘opposing’ recommendations if a woman eliminated foods from the three food groups defined within government recommendations (i.e., body-building foods, energy foods, protective foods). The opposite coding was used for food additions: intentionally adding sugary and packaged foods was coded as ‘opposing’ recommendations, while adding foods from the three food groups were coded as ‘meeting’ recommendations. Foods that fell outside government recommendations (e.g., chilis peppers) were coded as ‘neutral’. Food avoidances and additions were presented as *n* (%) for pregnancy and each postpartum period. The number of women with food avoidances opposing government recommendations was presented (*n*, %) for each timepoint. Food additions

of these women were assessed at each corresponding timepoint to determine if avoided foods were replaced by food additions from the same Cambodian food group.

3.7.3 Objective 3: Assessing differences by sociodemographic characteristics

Logistic regression models with backward elimination were built to identify sociodemographic and health characteristics that predict maternal food avoidances and additions during pregnancy and postpartum (121). Dietary modifications were dichotomized (i.e., yes/no for following food taboos, yes/no for adding foods to diet). Women's age (years), annual household income (USD), number of antenatal care visits attended, number of pregnancies, and number of live births were assessed as continuous variables, while maternal education and wealth quintiles were assessed as categorical variables. Maternal experience of pregnancy loss was computed based on the number of pregnancies and number of live births reported by women, and assessed for inclusion in the logistic regression models as a dichotomous variable. Each variable of interest was assessed for marginal statistical association with food avoidances/food additions using a univariate analysis (retained if $p < 0.25$) (122). Relevant continuous variables were next assessed for collinearity, with elimination of redundant variable when $r > 0.7$ (123). Number of pregnancies and live births were highly correlated ($r = 0.882$); the number of pregnancies was eliminated as a variable as the difference in the number of pregnancies and live births was already represented by the experience of pregnancy loss.

No model was built for food avoidances during pregnancy as only one variable met the cut-off for the univariate analysis (level of maternal education, $p = 0.174$). Variables included in the three other models were as follows: age, number of antenatal care visits, and number of live births in

model for pregnancy food additions; age and number of live births in model for postpartum food avoidances; and annual household income and number of live births in model for postpartum food additions.

3.8 Potential source of bias

This research project involves the examination of culturally related dietary choices in a country that is foreign to the researcher. In such circumstances, there is a risk of cultural bias, where the researcher misinterprets information due to their own cultural lens. The risk of cultural bias was minimized through regular consultations with the study's principal investigator and other members of her research team; all have substantial knowledge of Cambodia and Khmer culture, having jointly spent numerous years living in Cambodia. Another important resource for culturally relevant information was study co-investigator Mr. Hou Kroeun (Deputy Country Director, Helen Keller International, Cambodia). Mr. Kroeun provided valuable insights on topics such as the Cambodian peripartum dietary recommendations. It is also pertinent to note that efforts to mitigate cultural bias were included in the data collection process. A Cambodian research team member involved in data collection, Ms. Sreang Sambo, provided translation of terms from Khmer to English and contextualized cultural phenomena to the primary researcher.

4.0 Dissemination of Findings

The findings of this study will be shared with community actors within Cambodia such as the Cambodian Nutrition Working Group. Further dissemination of the findings in Cambodia will be guided by the knowledge and expertise of local stakeholders to ensure that information reaching the wider community is relevant and adapted to their needs. Results from this research will also be presented at an academic nutrition conference (e.g., Canadian Nutrition Society) in 2023, and published in an open-source, peer-reviewed journal (e.g., Maternal & Child Nutrition).

5.0 Results

5.1 Participant characteristics

Participant characteristics are detailed in **Table 5-1**. Women had a mean (SD) age of 28 (6) years and had experienced 2.5 (1.4) pregnancies. All participants were of Khmer ethnicity, and nearly all (99%) were married. Most women had less than seven years of formal education (60%) and were part of the three lower relative wealth quintiles (77%). Participants in this study had attended, on average, approximately five antenatal care visits during their most recent pregnancy, with the majority (92%) having a midwife as their antenatal healthcare provider.

5.2 Description of peripartum dietary modifications

Table 5-2 details peripartum dietary changes observed within the study sample. Food avoidances and food additions were reported at all four peripartum timepoints: pregnancy, zero to two weeks postpartum (early postpartum), two to 12 weeks postpartum (mid postpartum), and 12 to 24 weeks postpartum (late postpartum).

Considering all postpartum periods together, 71% of our study sample followed food taboos and 69% intentionally added food to their diet. Food avoidances were most frequent during the early postpartum period, with 66% of women avoiding at least one food or beverage. At all other timepoints, fewer than one in five women engaged in food avoidance. Food additions were most frequent during the late postpartum period, with 45% of women intentionally adding at least one food or beverage to their diet. At other peripartum periods, roughly one in three women engaged in food additions. Large portions of the study sample reported making no dietary changes (i.e., no avoidances or additions) during the peripartum period.

Table 5-1. Characteristics of study participants (*n*=335).

| Participant characteristic | Mean (SD) or <i>n</i> (%) |
|---|----------------------------------|
| Age, <i>years</i> | 28.1 (6.1) |
| Number of pregnancies | 2.5 (1.4) |
| Number of live births | 2.2 (1.1) |
| Marital status, <i>married</i> | 330 (99%) |
| Ethnicity, <i>Khmer</i> | 335 (100%) |
| Maternal education | |
| <i>No formal education</i> | 40 (12%) |
| <i>Primary (1-6 years)</i> | 161 (48%) |
| <i>Lower secondary (7-9 years)</i> | 83 (25%) |
| <i>Upper secondary (10-12 years)</i> | 43 (13%) |
| <i>Higher education</i> | 8 (2%) |
| Occupation | |
| <i>Homemaker</i> | 163 (49%) |
| <i>Farmer</i> | 94 (28%) |
| <i>Unemployed</i> | 23 (7%) |
| <i>Seller</i> | 22 (7%) |
| <i>Garment factory worker</i> | 4 (1%) |
| <i>Other</i> | 29 (9%) |
| Relative wealth quintile ¹ | |
| <i>Quintile 1 (Poorest)</i> | 81 (24%) |
| <i>Quintile 2</i> | 69 (21%) |
| <i>Quintile 3</i> | 108 (32%) |
| <i>Quintile 4</i> | 54 (16%) |
| <i>Quintile 5 (Wealthiest)</i> | 23 (7%) |
| Median household income, <i>USD (past 12 months)</i> ² | 2,000 (IQR 1,000-3,000) |
| Number of antenatal care visits | 4.8 (2.4) |
| Antenatal care provider | |
| <i>Midwife</i> | 307 (92%) |
| <i>Doctor</i> | 16 (5%) |
| <i>Other</i> | 5 (1%) |

Note: Percentages in table may not add up to 100% due to rounding.

¹ Relative wealth quintiles were calculated using the EquityTool for Cambodia (113).

² Annual household income is presented as median (IQR).

Foods targeted by women for avoidance during peripartum periods were far from universal. For instance, in early postpartum, 114 unique foods were avoided by women in the study sample. A wide range of foods were also added to the peripartum diet (e.g., 43 different foods were added to women's diets in early postpartum). For nearly all peripartum periods, engaging in food avoidances and additions was not the norm: the median number of foods avoided or added per

woman was zero for all instances except early postpartum (median of one food avoidance per woman). The maximum number of foods avoided by an individual woman at one peripartum period was six, while the maximum for foods added was five (see **Table 5-2**).

Table 5-2. Dietary modifications by peripartum period.

| | Pregnancy (<i>n</i> =335) <i>n</i> (%) | Early postpartum (<i>n</i> =335) <i>n</i> (%) | Mid postpartum (<i>n</i> =310) <i>n</i> (%) | Late postpartum (<i>n</i> =298) <i>n</i> (%) |
|--|--|---|---|--|
| Dietary modification by women ¹ | | | | |
| Avoided foods | 59 (18%) | 221 (66%) | 53 (17%) | 55 (18%) |
| Added foods | 126 (38%) | 123 (37%) | 100 (32%) | 133 (45%) |
| No modification | 179 (53%) | 96 (29%) | 183 (59%) | 127 (43%) |
| Number of unique foods avoided in sample | 36 | 114 | 35 | 41 |
| Number of unique foods added in sample | 54 | 43 | 56 | 31 |
| Median number of foods avoided per woman | 0 (IQR 0) | 1 (IQR 0-2) | 0 (IQR 0) | 0 (IQR 0) |
| Number of foods avoided per woman (range) | 0-4 | 0-6 | 0-6 | 0-3 |
| Median number of foods added per woman | 0 (IQR 1) | 0 (IQR 1) | 0 (IQR 1) | 0 (IQR 1) |
| Number of foods added per woman (range) | 0-4 | 0-5 | 0-3 | 0-2 |

¹ Total % in columns surpasses 100% since some women both avoided and added foods in their diet

The number of foods individual women avoided or added to their diet differed significantly by peripartum timepoint [χ^2 (3) 294.805, $p < 0.001$ for food avoidances, and χ^2 (3) 8.464, $p = 0.037$ for food additions]. Specifically, the number of foods avoided during early postpartum differed significantly compared to all other peripartum periods ($p < 0.001$ compared to pregnancy, mid postpartum, and late postpartum). The number of food additions differed only between pregnancy and mid postpartum ($p < 0.001$).

5.3 Characteristics of foods avoided and added to maternal diets

Table 5-3 lists the five most frequent foods avoided and added for each peripartum period.

During pregnancy, the most frequently avoided foods were spicy foods, energy drinks, and coffee, while during the postpartum period, fish without scales, raw vegetables, and fermented foods were most avoided. The most common food additions during pregnancy were milk, soymilk, and juice. During postpartum, women most frequently added traditional medicine, soups made with fish and/or meat, and soymilk to their diets.

Table 5-3. Most frequent food avoidances and additions by peripartum period.

| | Pregnancy | Early postpartum | Mid postpartum | Late postpartum |
|----------------|-------------------------------|---------------------------------------|--------------------------------------|---|
| Food avoidance | Spicy foods ¹ (20) | Fish without scales ² (71) | Raw vegetables ³ (11) | Fermented foods ⁴ (8) |
| | Energy drinks (12) | Raw vegetables ³ (57) | Fermented foods ⁴ (8) | Fish without scales ² (6) |
| | Coffee (10) | Fermented foods ⁴ (25) | Fish without scales ² (8) | Canned drinks ⁶ (5) |
| | Alcohol (9) | Chicken (20) | Buffalo meat (7) | Bamboo, buffalo meat, ice, <i>chek ambong</i> ⁷ , raw vegetables ³ , sour fruit (all 3) |
| | Soft drinks (7) | Beef (18) | Sour foods ⁵ (6) | |
| Food addition | Milk (48) | Soymilk (53) | Soup with fish/meat (65) | Traditional medicine (96) |
| | Soymilk (42) | Juice (39) | Traditional medicine (22) | Soup with fish/meat (28) |
| | Juice (26) | Soup with fish/meat (23) | Meat dish ⁹ (9) | Soymilk (5) |
| | Coconut water (24) | Milk (20) | Vegetables ⁸ (7) | Milk (4) |
| | Vegetables ⁸ (14) | Vegetables ⁸ (10) | Vegetable soup (4) | Meat dish ⁹ (3) |

Note: Numbers in brackets indicate the number of women who avoided/added the specific food item at each timepoint.

¹ Examples include chili and black pepper

² Examples include catfish and eel

³ Examples include carrots, cucumbers, and tomatoes

⁴ Examples include *prahok* (i.e., fish paste), and fermented vegetables

⁵ Examples include tamarind, pineapple, and *voar yeav* leaves

⁶ Examples include soft drinks, energy drinks, and soymilk (sweetened or unsweetened)

⁷ *Chek ambong* is the most widely cultivated type of banana in Cambodia (124)

⁸ Examples include morning glory, sponge gourd leaf, Chinese kale, avocado, sauteed vegetables, and gourds

⁹ Meat dishes often contained vegetables (e.g., sauteed pork with mustard greens)

Foods that were avoided and added to the diet covered a wide range of food groups within the MDD-W classification system (see **Table 5-4**). During pregnancy, the most frequent food avoidance was of condiments or seasonings (25% of avoidances), including items such as chilis, spicy food, and fish paste. Sugar-sweetened beverages like energy drinks, soft drinks, sweetened condensed milk, and juices were also commonly avoided (23%), as were foods that fell in the “other” category (22%; e.g., alcohol, coffee, and betel leaf). Interestingly, sugar-sweetened beverages were also commonly added to the maternal diet during pregnancy, accounting for 22% of food additions. Milk and soymilk were other frequently added foods during pregnancy, accounting for 21% and 18% of additions, respectively.

During postpartum, food avoidances were primarily of meat/fish and “other” vegetables (39% and 22% of food avoidances, respectively; category “other vegetables” includes vegetables that are not particularly rich sources of vitamin A). Fish without scales (e.g., catfish), chicken, beef, and buffalo were among the most avoided animal products. Vegetables avoided included bamboo shoots, sponge gourd, eggplant, wax gourd, and cucumbers. Meat/fish were also added to women’s diets during postpartum, but less frequently than they were avoided (25% vs. 39%). “Other” vegetables were added to maternal diets in similar proportions as they were avoided (19% vs. 22%). This category comprised most frequently vegetables that were included in soups (e.g., in sweet soup, fish soup, and mixed vegetable soup). Finally, foods that fell in the “other” category were also regularly added to postpartum diets; traditional medicine was the most prominent food or beverage included in the “other” category during this period.

Table 5-4. MDD-W groups for foods that were avoided and added in peripartum.

| MDD-W group | Food avoidances | | Food additions | |
|--|---------------------------|----------------------------|---------------------------|----------------------------|
| | Pregnancy <i>n</i> (%) | Postpartum <i>n</i> (%) | Pregnancy <i>n</i> (%) | Postpartum <i>n</i> (%) |
| Grains, white roots and tubers, plantains | 5 (5%) | 17 (3%) | 1 (0%) | 8 (1%) |
| Pulses | 1 (1%) | 7 (1%) | 42 (18%) | 61 (9%) |
| Nuts, seeds | 0 (0%) | 1 (0%) | 0 (0%) | 0 (0%) |
| Dairy | 2 (2%) | 1 (0%) | 49 (21%) | 24 (4%) |
| Meat, poultry, fish | 7 (7%) | 239 (39%) | 12 (5%) | 169 (25%) |
| Eggs | 0 (0%) | 3 (0%) | 5 (2%) | 0 (0%) |
| Dark green leafy vegetables | 0 (0%) | 11 (2%) | 6 (3%) | 73 (11%) |
| Other vitamin A- rich fruit and vegetables | 1 (1%) | 2 (%) | 1 (0%) | 10 (1%) |
| Other vegetables | 10 (10%) | 136 (22%) | 16 (7%) | 127 (19%) |
| Other fruit | 3 (3%) | 54 (9%) | 17 (7%) | 16 (2%) |
| Sweets | 0 (0%) | 10 (2%) | 6 (3%) | 1 (0%) |
| Sugar-sweetened beverages | 22 (23%) | 40 (6%) | 52 (22%) | 46 (7%) |
| Condiments, seasonings | 24 (25%) | 27 (4%) | 1 (0%) | 0 (0%) |
| Other ¹ | 21 (22%) | 72 (12%) | 25 (11%) | 134 (20%) |

¹ Category includes items such as alcohol, betel leaf, coffee, tea, and traditional medicine

5.4 Reasons for food avoidances and additions

Study participants had a broad range of reasons for engaging in food avoidances and food additions, summarized in **Figure 5-1**. The most common motivator for these dietary changes was the promotion of health. Other important reasons for food avoidances and additions were to provide energy to the mother and to support the production of breastmilk. Less frequently, women engaged in food avoidances and additions to satisfy peripartum-acquired dietary preferences, follow traditions, enhance beauty, and prevent death.

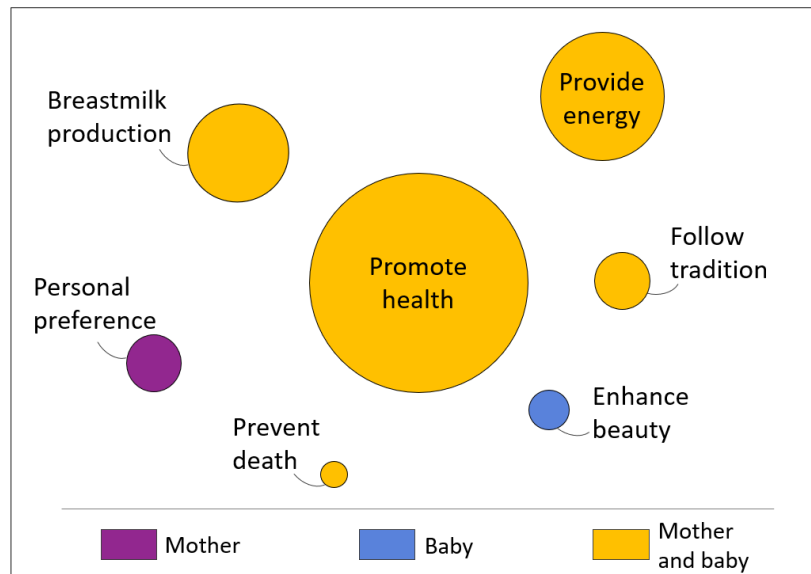


Figure 5-1. Categorization of reasons for peripartum dietary changes, by frequency.

Note: Circle size represents the overall frequency of each category, while the colors represent the intended beneficiary of the dietary modification.

The desire to promote baby's health was most prominent during pregnancy, while promoting maternal health became most important after childbirth (see **Table 5-5**). Reasons related to the promotion of baby's health included avoiding general illness or specific symptoms (e.g., diarrhea, fever, stomach aches, cough), and supporting growth and development (e.g., development of brain, heart, and bones, supporting vision, avoiding premature birth). The promotion of maternal health also commonly involved concerns around general sickness and specific symptoms (e.g., diarrhea, stomach ache, headaches, dizziness, difficulty breathing, seizures), as well as the aim to enhance strength and recovery from delivery or Caesarean-section, and to support reproductive health (e.g., health of womb).

The desire to increase maternal energy was prominent during all peripartum periods, while concerns around supporting breastmilk production were almost exclusively voiced during

postpartum periods. Both issues were addressed mainly through food additions, with beliefs emerging that various soups, vegetables, meats, fish, juices, soymilk, milk, coconut water, and traditional medicine could enhance breastmilk production. Study participants avoided and added foods to their diets to satisfy newly-acquired preferences or aversions and adhere to traditions. Elders were seen to be the most frequent influencers on dietary behaviours, but family members (e.g., mothers, aunts) and other community members were also influential. During pregnancy, both food avoidances and food additions were used to enhance the beauty of the baby, while food avoidances alone were used to prevent maternal and infant death.

Table 5-5. Frequency of reasons women engaged in food avoidances and additions.

| Reasons | Frequency | | | |
|------------------------------|----------------|------------|---------------|------------|
| | Food avoidance | | Food addition | |
| | Pregnancy | Postpartum | Pregnancy | Postpartum |
| Promote health | 72 | 442 | 63 | 147 |
| Of mother | 29 | 357 | 19 | 123 |
| Of baby | 41 | 78 | 40 | 8 |
| General health | 2 | 7 | 4 | 16 |
| Provide energy | - | 1 | 93 | 118 |
| For mother | | 1 | 89 | 116 |
| For baby | | - | 4 | 2 |
| Breastmilk production | - | 11 | 4 | 126 |
| Personal preference | 2 | 3 | 15 | 18 |
| Follow tradition | 2 | 22 | 2 | 4 |
| Enhance beauty | 5 | - | 9 | - |
| Prevent death | 3 | 5 | - | - |
| Of mother | - | 5 | | |
| Of baby | 3 | - | | |
| TOTAL | 84 | 484 | 186 | 413 |

Reasons for the avoidance of specific food items were not consistent throughout the study sample (see **Table 5-6**). For example, among the 20 women who reported avoiding spicy food, numerous reasons were provided for this avoidance: it makes the baby cry, affects baby's health, makes the baby hot, causes stomach aches, causes headaches, or results in thick amniotic fluid.

Fish without scales, a food avoided by 83 women postpartum, had an even broader range of reasons for its avoidance: it was thought to cause sickness, diarrhea, stomach aches, headaches, food poisoning, bleeding, make the baby sick, adversely affect maternal health, affect the womb, make the womb itchy, impede the healing of wounds, cause wound infections, cause the woman to “roll like an eel”, or cause maternal death. Some participants also avoided this food because of outside influences (advised by elders or family members) or due to a peripartum-acquired food preference.

Additions of the same foods were also motivated by a variety of reasons (see **Table 5-7**). Milk, added to the pregnancy diets of 48 women, was believed to provide energy to mother and baby, be good for baby and mother’s health, make the baby beautiful, help the baby grow, give the baby nice skin, be good for baby’s bones and overall strength, help produce red blood cells, produce more amniotic fluid, produce more milk, cause a stable temperature in the body, provide vitamins to baby, and help ensure an easy delivery. Additionally, one participant added milk to her diet as it was a peripartum-acquired food preference, while another woman was following advice she received from community members. Traditional medicine was added to the postpartum diet of 107 women. Few details were provided on the traditional medicines used by participants; some specified the use of traditional wines, Khmer traditional medicine, or boiled traditional medicines. Participants reported that they used traditional medicine to help their body regain strength, produce more breastmilk, prevent sickness, help them eat more, for the health of their womb, general health, to help with healing or pain, fever, diarrhea, blood cell production, to help with constipation, protect bones, to prevent headaches, to treat leukorrhea, to treat intestinal illness, or to help with sleeping. Women also added traditional medicines to their diet in response to advice from elders.

Table 5-6. Reasons women engaged in food avoidances for the most commonly avoided foods.

| | | |
|-------------------|---|---|
| Pregnancy | Spicy foods (20) | |
| | - Makes baby hot | - Causes stomach aches [†] |
| | - Affects baby | - Causes headaches [†] |
| | - Affects baby's health [†] | - Causes thick amniotic fluid [†] |
| | - Makes baby cry [†] | |
| | Energy drinks (12) | |
| | - Affects baby* | - Affects mother [†] |
| | - Affects baby's growth [†] | - Affects stomach [†] |
| | - Baby will get fat [†] | - Advice from neighbour [†] |
| | - Affects health [†] | - Causes sickness [†] |
| | Coffee (10) | |
| | - Affects baby | - Causes diabetes [†] |
| | - Affects baby's growth | - Reduces effectiveness of iron supplement [†] |
| | - Causes baby to have black skin [†] | - Causes vomiting [†] |
| | - Affects baby's heart [†] | |
| | - Affects baby's brain development [†] | |
| Postpartum | Fish without scales (83) | |
| | - Causes sickness | - Causes headaches |
| | - Affects maternal health [†] | - Wounds won't heal |
| | - Affects womb | - Causes wound infection |
| | - Causes itchy womb [†] | - Causes fever [†] |
| | - Causes bleeding [†] | - Makes baby sick [†] |
| | - Advice from elders | - Afraid of rolling like an eel [†] |
| | - Causes diarrhea | - Family habit [†] |
| | - Causes stomach aches | - Peripartum-acquired dislike [†] |
| | - Causes food poisoning [†] | - Afraid of dying after eating [†] |
| | Raw vegetables (67) | |
| | - Causes diarrhea | - Affects womb [†] |
| | - Baby will get diarrhea | - Affects baby [†] |
| | - Causes sickness | - Causes sickness that reduces breastmilk production [†] |
| | - Causes food poisoning | - Peripartum-acquired dislike [†] |
| | - Causes stomach aches | - Hot food [†] |
| | - Baby will get a stomach ache | - Advice from elders [†] |
| | - Causes dizziness | |
| | - Causes bloating/gas | |
| | Fermented foods (31) | |
| | - Causes diarrhea | - Causes food poisoning [†] |
| | - Causes stomach aches | - Causes bloating/gas [†] |
| | - Causes sickness | - Causes allergies [†] |
| | - Causes cough | - Affects breastmilk production [†] |
| | - Baby will get a cough | - Advice from elders [†] |
| | - Baby will get a cold | - Advice from doctor [†] |
| | - Baby will get diarrhea | - Affects womb [†] |
| | - Baby will get sick | - Causes reproductive health issues [†] |
| | - Baby will get allergies | - Causes wound infection [†] |
| | - Baby will get a fever [†] | - Affects wounds [†] |
| | - Affects health [†] | |

Numbers in brackets indicate the number of women who avoided each food/beverage. Postpartum period includes responses from early, mid, and late postpartum. All reasons listed refer to the mother unless otherwise noted.

* Reason provided by ≥50% of women for that specific food/beverage

[†] Reason provided by only one woman for that specific food/beverage

Table 5-7. Reasons women engaged in food additions for the most commonly added foods.

| | | | |
|------------------|-----------------------------------|---|--|
| Pregnancy | Milk (48) | <ul style="list-style-type: none"> - Provides energy to mother* - Provides energy to baby† - Good for mother's health - Good for baby's health - Makes baby beautiful - Gives baby nice skin - Helps with baby's growth - Provides vitamins to baby† - Strengthens baby's bones† - Makes baby strong† | <ul style="list-style-type: none"> - Helps with blood cell production† - Helps produce more amniotic fluid† - Helps produce more breastmilk† - Helps maintain a stable temperature in body† - Easier delivery† - Mother can only drink this† - Does not have carbonation† - Peripartum-acquired preference† - Advice from others† |
| | Juice (44) | <ul style="list-style-type: none"> - Provides energy* - Good for baby's health - Prevents baby from being fat - Makes baby beautiful - Gives baby good hair† - Provides energy to baby - Helps with baby's growth† - Provides vitamins for baby† | <ul style="list-style-type: none"> - Rich in vitamins† - Good for baby† - Helps produce more amniotic fluid† - Good for mother's health† - Helps produce more breastmilk† - Easier delivery - Peripartum-acquired preference |
| | Soymilk (42) | <ul style="list-style-type: none"> - Provides energy* - Good for baby's health - Makes baby beautiful† - Helps with baby's growth† | <ul style="list-style-type: none"> - Beverage that is enjoyed† - Afraid to consume other foods† - Helps maintain a stable temperature in body† |
| | Postpartum | | |
| | Traditional medicine (107) | <ul style="list-style-type: none"> - Quicker recovery of strength* - Helps with healing - Prevents sickness - Helps mother eat more rice - Helps mother eat more food - Good for womb - Good for mother's body - Good for mother's health - Prevents/treats fever - Prevents/treats pain in body - Prevents diarrhea - Helps produce more breastmilk - Produces blood cells† | <ul style="list-style-type: none"> - Helps with doing heavy tasks† - Helps mother feel good - Cold body temperature† - Helps with constipation† - Protects bones† - Advice from elders - Advice from others† - Prevents headaches† - Treats leukorrhea† - Treats intestines† - Good for diet† - Good for sleeping† |
| | Fish/meat soups (98) | <ul style="list-style-type: none"> - Helps produce more milk* - Provides energy - Peripartum-acquired preference - Good for mother's health - Good for baby's health† - Helps with baby's growth | <ul style="list-style-type: none"> - Rich in vitamins - Quicker recovery of strength† - Prevents sickness† - Habit† - Good for blood cells† |
| | Soymilk (58) | <ul style="list-style-type: none"> - Provides energy* - Helps produce more breastmilk | <ul style="list-style-type: none"> - Peripartum-acquired preference† - Easy to consume† |

Numbers in brackets indicate the number of women who added each food/beverage. Postpartum period includes responses from early, mid, and late postpartum. All reasons listed refer to the mother unless otherwise noted.

* Reason provided by ≥50% of women for that specific food/beverage

† Reason provided by only one woman for that specific food/beverage

5.5 Alignment of dietary modifications with Cambodian government recommendations

Food avoidances during pregnancy largely aligned with the government's recommendations for peripartum nutrition: most pregnancy avoidances were either neutral regarding the government's recommendations (38%) or met recommendations (35%). Neutral avoidances included items such as chilis and coffee, while positive avoidances included alcohol and sugar-sweetened beverages. During postpartum periods, the majority of food avoidances (62%) were in direct opposition to government recommendations (e.g., avoidance of “protective foods” such as fruits and vegetables).

Food additions during pregnancy mainly met the government's peripartum nutrition recommendations. Women commonly added bodybuilding foods like milk and soymilk during pregnancy. Food additions that went against government recommendations were mainly sugary foods such as juices and energy drinks. Neutral food additions included coconut water, green tea, and items containing one ingredient that met the government recommendations while another went against it (e.g., fruit shakes made with fresh fruit and added sugar). Alignment of postpartum food additions with the government's recommendations was more variable. In early and mid postpartum, women mainly added soups and mixed dishes containing meat/fish and vegetables: these additions met the government's recommendations. During late postpartum, the addition of traditional medicine was widespread (accounts for 70% of additions during this period), despite the government advising against this practice. As such, most food addition in late postpartum do not align with government recommendations (see **Table 5-8**).

Table 5-8. Alignment of dietary modifications with the Cambodian government's peripartum nutrition recommendations.

| | Opposes recommendations <i>n</i> (%) | Meets recommendations <i>n</i> (%) | Neutral <i>n</i> (%) |
|-----------------------|---|---|---------------------------------|
| Food avoidance | | | |
| Pregnancy | 26 (27%) | 33 (35%) | 36 (38%) |
| Early postpartum | 291 (62%) | 107 (23%) | 70 (15%) |
| Mid postpartum | 47 (59%) | 16 (20%) | 17 (21%) |
| Late postpartum | 41 (59%) | 8 (12%) | 20 (29%) |
| Food addition | | | |
| Pregnancy | 52 (24%) | 131 (61%) | 32 (15%) |
| Early postpartum | 45 (24%) | 139 (74%) | 3 (2%) |
| Mid postpartum | 24 (17%) | 116 (83%) | 0 (0%) |
| Late postpartum | 108 (72%) | 43 (28%) | 0 (0%) |

Note: Data are presented by food item (women who avoided or added multiple food items are represented multiple times in table). Percentages correspond to the alignment of dietary modifications for each timepoint (rows).

In instances where food avoidances went against the Cambodian government's recommendations (i.e., avoidance of energy foods, bodybuilding foods, or protective foods), women often did not report adding foods of similar nutritional value to their diet. During pregnancy, only 6% of women added foods from the same food group (e.g., both avoidance and addition of a bodybuilding food). During postpartum periods, only 13-30% of women replaced these avoided foods with foods from the same Cambodian food group (see **Table 5-9**).

Table 5-9. Replacement of avoided foods with foods in the same Cambodian food group, by woman

| | Avoidance opposes recommendations <i>n</i> | Addition of food from same food group <i>n</i> (%) |
|------------------|---|---|
| Pregnancy | 18 | 1 (6%) |
| Early postpartum | 161 | 41 (25%) |
| Mid postpartum | 30 | 9 (30%) |
| Late postpartum | 32 | 4 (13%) |

Note: Data are presented by woman; food groups are based on the government of Cambodia classification system (i.e., energy foods, bodybuilding foods, protective foods).

5.6 Predictors of dietary modifications

None of the demographic and health variables included in our analyses were predictive of food additions or avoidances during pregnancy. Only the number of live births was a significant predictor for engaging in both food avoidances and additions during the postpartum period: for every additional live birth, the odds of a woman engaging in postpartum food avoidances decreased by 24% (OR 0.76 [0.61-0.95]). The odds of a woman engaging in postpartum food additions also decreased by 20% (OR 0.80 [0.64-0.99]) per additional live birth.

6.0 Discussion

Among our sample of 335 women living in Kampong Thom, Cambodia, food taboos were prevalent during the first two weeks postpartum but less common in later postpartum periods and pregnancy. Pregnancy food taboos often had beneficial or neutral impacts on the dietary intakes of women, as the most frequently avoided foods were coffee, energy drinks, alcohol, and spicy foods. Postpartum food taboos may be more consequential to the health of women and children, as frequently restricted foods included meats, fish, fruits, and vegetables. However, avoidance of these foods did not commonly extend beyond the first two weeks postpartum, which would limit their health impact. Food additions were more prevalent than food avoidances during pregnancy, mid postpartum, and late postpartum. Participants in our study specifically chose to add nutritionally desirable foods to their diets, such as various soups, meats, and soymilk, alongside items of poor or uncertain nutritional quality (e.g., sugar-sweetened beverages and traditional medicine).

Women provided numerous reasons for engaging in peripartum food avoidances and additions, most of which centered on the desire to promote maternal and infant health. Sociodemographic and health characteristics did not impact whether a woman engaged in food avoidances or additions during pregnancy. During postpartum, the more children a woman birthed, the lower the odds of her engaging in either food restrictions or additions in her diet.

6.1 Prevalence and types of food taboos and additions in Cambodia

This study revealed a wide breadth of foods being avoided and added to the maternal diet in rural Cambodia. Specific foods avoided and added by women in Kampong Thom largely corroborated

and expanded on the findings of previous studies conducted in other regions of the country (3,5,6,104,106,107). Some notable differences include that in our sample, there was no avoidance during pregnancy of oily foods (107) or foods that would be considered ‘hot’ in humoral theory (3,107). In postpartum, none of our participants specified avoiding salty foods (5). Some of the foods avoided in our study would fall into these categories (e.g., some women avoided *prahok*, a salty food), but no participant stated that she avoided all foods from the above-mentioned categories. A striking difference for food additions was that women did not add traditional rice wine to their diet during pregnancy, unlike findings from Montesanti *et al.*, who reported this practice among women in southern Cambodia a decade ago (3).

We found that although a wide variety of foods are considered taboo for pregnant and lactating women in Cambodia, individual women tended to restrict a limited number of foods at once. For instance, the maximum number of foods avoided by one woman during pregnancy was four, despite 54 unique foods being avoided within the study sample. The lack of universality in food taboos suggests that there isn’t a strict cultural understanding of which foods are harmful or socially acceptable during pregnancy and lactation. Instead, there appears to be a more localized or individualized interpretation of food taboos. This variability in individual-level food avoidances has also been observed in Malaysia (125). A qualitative study with 55 women residing in the country's northern region noted that “despite general guidelines, each person follows rules slightly different from the other and what is taboo for one person may not be for another” (125). Accordingly, when consulting lists of food taboos for women in Cambodia, it is essential to be aware that each woman will likely be adhering to specific, individualized food taboos.

Among our study sample, the prevalence of food taboos was much higher postpartum than in pregnancy (71% vs. 18%), with most of these avoidances occurring in the first two weeks after delivery. This finding is congruent with traditional beliefs in Cambodia, as postpartum women are understood to be in a particularly fragile, weak state (3,6,104), and participants largely followed food taboos to protect maternal health. The high prevalence of food taboos during the first two weeks postpartum is intriguing as it coincides with the period during which *ang pleung* (postpartum roasting) or ‘heat’ injections would be performed (104). These practices are used to heat the body and promote maternal recovery. Previous studies have indicated that women both intentionally restrict and add foods during *ang pleung* (6,109), but the relationship between postpartum dietary behaviours and heating practices has not been thoroughly explored. Further examination of this relationship could provide a deeper understanding of potential motivators for postpartum food avoidances and additions.

Another notable finding of our study is that food additions were more common than food avoidances for the vast majority of the peripartum period; the only time the prevalence of food avoidances exceeded that of food additions was during the first two weeks postpartum. Overall, women added a variety of nutritious foods to their diets. These additions generally aligned with the Cambodian government’s peripartum dietary recommendations since they provided women with additional sources of energy, fats, protein, and micronutrients (76). Many of the food additions (e.g., soups, soymilk, milk) could help increase a woman’s fluid intake, which is also beneficial for the health of pregnant and lactating women (126). Some women both avoided and added foods to their diet concurrently. We observed that when this occurred, the foods avoided and added were generally not from the same Cambodian food group (i.e., energy foods,

bodybuilding foods, or protective foods). However, we lack the ability to assess whether avoided foods have been adequately replaced in women's diets. For instance, rather than adding specific foods to their diets, women may have increased the volume of foods already consumed in their diets; this action could counterbalance the nutritional void created by food avoidances. Overall, the beneficial qualities of foods added to the maternal diet and the limited adherence to food taboos hint at positive maternal dietary behaviours. Findings from this study could suggest that messaging around maternal diet provided through existing public health campaigns and antenatal care visits is being effectively integrated into the behaviours of many women in Kampong Thom.

The high use of traditional medicine by study participants is also noteworthy: 107 women added traditional medicine to their postpartum diet, most commonly in late postpartum. This practice directly opposes the recommendations of the Cambodian government, which views traditional medicine as presenting a potential risk to the health of pregnant and lactating women (76). Study participants did not describe the traditional medicines they used beyond some women stating they consumed "traditional wine", "Khmer traditional medicine", or "boiled traditional medicine". There is little information on what is typically contained in these traditional medicines in the literature. Many *kru khmer* (traditional healers) make their own medicines and prefer to conceal the specific ingredients used to avoid having their recipes appropriated by others (127). Richman *et al.* examined traditional medicines through their hospital and clinic work in Cambodia. They noted that peripartum women often drink teas provided to them by a *kru khmer* made from varieties of wood and leaves (107). Additional studies have observed that traditional wine is composed of a rice wine base with some of the following ingredients: herbs (104,107,127), parts of wild animals (107,127), tree bark (3,107), tree roots (3), or beeswax

(104). No studies appear to have examined the effectiveness of traditional Cambodian medicines used during the peripartum period; therefore, we cannot know how these products impact the health of women and children. One potential risk with using traditional medicines would be the delay in seeking Western biomedical attention for treatable ailments (6,128), which could impact the effectiveness of these evidence-based treatments and prolong a woman's state of illness. Healthcare practitioners in Cambodia should assess the traditional medicine practices of individual patients and identify any potential risks with using these medicines. For example, if a patient uses traditional wine during pregnancy and postpartum, it would be essential for healthcare practitioners to explain the potential health outcomes of consuming alcohol during these periods of the lifecycle (e.g., detrimental long-term effects on child cognition (129)). It is also important for healthcare workers to counsel patients on the specific signs and symptoms that could represent a medical emergency during pregnancy and postpartum (e.g., prolonged vaginal bleeding, high fever, dizziness (130)) and warrant attention from a licensed medical professional.

6.2 Regional prevalence of food taboos

The frequency of pregnancy food taboos (18% of women) in Kampong Thom, Cambodia falls between trends observed in other Southeast Asian countries. Pregnancy food taboos were nearly nonexistent in studies conducted in various regions of Laos (131–134). In Indonesia, a longitudinal study using repeat 24-hour dietary recalls found that among 450 women, 28% followed pregnancy food taboos (135). In Malaysia, a cross-sectional study identified that 70% of women ($n=73$ of 104) avoided foods during this period (136). Pregnancy food taboos differ drastically between Southeast Asian countries; therefore, researchers and health professionals

cannot presume that dietary behaviours observed in pregnancy in one country will present in another.

Postpartum food taboos are far more prominent across Southeast Asia. Despite 71% of our study sample engaging in postpartum food avoidance, this practice is slightly less prevalent and less strict than in neighbouring countries. In Laos, Barennes *et al.* conducted a cross-sectional study with 300 urban-dwelling women, of whom 93% adhered to food taboos (137). These avoidances led to highly restrictive maternal diets, particularly for the first two weeks postpartum: during this period, 15% of women consumed only glutinous rice with salt, 36% consumed only rice with dry meat or fish, and 49% consumed only glutinous rice with salt for the first three days postpartum, then added in a limited amount of other food items (e.g., cooked vegetables) (137). Barennes *et al.* conducted another cross-sectional study in rural Laos, finding that 98% of mothers ($n=125$ of 127) engaged in postpartum food avoidances lasting for a median of 30 days (138). Similar to their urban peers, women generally only ate milled glutinous rice soaked in water and tea during this time (138). Other quantitative studies in Laos have found that 80% (132) to 97% (133) of women adhere to postpartum food taboos. In rural and urban regions of Myanmar, 96% of women ($n=188$ of 196) practiced dietary restrictions postpartum (139), while a study with 115 women living in urban Vietnam found all participants restricted certain foods in their postpartum diet (140). Postpartum food taboos are also reportedly prevalent in peri-urban Myanmar (141) and Malaysia (142). The near-ubiquitous presence of restrictive postpartum diets in Southeast Asia may lead to inadequate nutrient intakes and stores for women and breastfeeding infants. The nutritional impact of food taboos would be directly influenced by the types of foods avoided and the duration of such avoidances.

6.3 Potential nutritional and health implications

During pregnancy, the dietary modifications of Cambodian women appear overall to be beneficial for the health of women and children. Women avoided foods during pregnancy that have been demonstrated to negatively impact the health of the dyad, including alcohol (129), coffee (143,144), energy drinks (144), and other sugar-sweetened beverages (145). The most common food avoidance, spicy food, would not impact health if women were simply eliminating spicy ingredients (e.g., chilis) from their cooking. Some women avoided nutrient-rich foods such as eggplant, pineapple, chicken, or milk, but this was not common in pregnancy. Many more women chose to intentionally add nutritious foods to their diets during pregnancy, providing themselves—and thus their fetus—with rich sources of protein, fat, calcium, and other micronutrients. A limited number of women intentionally chose to include sugar-sweetened beverages and desserts in their diets. These foods could present issues if consumed excessively, as high sugar intake in pregnancy can lead to outcomes such as excessive gestational weight gain, gestational diabetes, preeclampsia, and preterm birth (146). However, this is unlikely to be a major concern as intake of sugary foods and beverages is limited in Cambodia, with residents in Kampong Thom consuming roughly 21 g of sugar per day (17).

Postpartum food taboos could be more consequential to the health of women and children, as roughly 60% of avoidances were of nutritionally dense foods. Of particular concern was the frequent avoidance of different varieties of fish. As discussed previously, fish is a major dietary staple in the Cambodian diet (18) and an important source of key nutrients such as protein, fats, vitamin D, riboflavin (90), and iodine (92). Avoidance of specific vegetables such as bamboo shoots, sponge gourd, eggplants, and raw vegetables was also common among our study

participants. The government advises all Cambodians to avoid raw foods due to the risk of foodborne illness; as such, the avoidance of raw vegetables is viewed as healthy. Restricting other vegetables in the maternal diet is undesirable as they are sources of essential nutrients for women and infants, such vitamin A and folate. Adhering to postpartum food taboos has been seen to reduce dietary diversity (133) and alter women's nutrient intakes (137,142) in other Southeast Asian countries. For instance, during the first two weeks postpartum, women in Laos consumed significantly less protein and micronutrients as compared to women who were beyond two weeks postpartum. As indicated previously, food taboos are particularly strict in Laos during this early postpartum period. Specific differences observed by Barennes *et al.* included reduced intakes of protein (61 g vs. 108 g), thiamine (0.4 mg vs. 0.9 mg), vitamin C (26 mg vs. 56 mg), retinol (20 mg vs. 103 mg), iron (9 mg vs. 15 mg), and calcium (311 mg vs. 456 mg) (137). Intakes of lipids and energy were the only two components that did not change between these timepoints (137). The nutritional and health impact of the food taboos we documented in Kampong Thom, Cambodia, would likely be minimal for most women due to the generally short duration of food avoidances paired with a less restrictive diet than what is observed in Laos.

Although taboos were common, women also intentionally added many nutritionally desirable foods to their diets during the first three months postpartum. The addition of soups, vegetables, and meat-based dishes was widespread. These foods could help women increase their fluid intake and provide numerous key nutrients required while breastfeeding. However, by late postpartum, women were mostly adding traditional medicines to their diets. Few women reported intentionally adding nutrient-rich foods to their diet from three to six months postpartum. During earlier postpartum periods and in pregnancy, roughly two-thirds of women made no intentional

food additions. The prevalence of this practice is concerning, as nutritional needs during pregnancy and lactation are heightened, and most women in Cambodia breastfeed their infants beyond six months of age (22). Guidelines provided by the government of Cambodia recommend for women to consume an extra daily meal during this period of the lifecycle, focusing on foods that are good sources of protein, fat, calories, and micronutrients (76). Without intentionally adding foods to their peripartum diets, women in Cambodia could have difficulties meeting their nutritional needs during these periods of the lifecycle. As previously mentioned, the prevalence of food additions in our study must be interpreted with caution: it is possible some women did not report adding foods to their diet because they simply increased the volume of foods they regularly consume, with these food increases fulfilling women's increased dietary requirements. However, suppose women in our study did not make this dietary adjustment: this could present nutritional risks for women and children, as women's diets in Cambodia are frequently lacking essential nutrients required during pregnancy and lactation (22,87–89).

6.4 Rationale for food avoidances and additions

Maternal and infant health was a strong motivator for the dietary behaviours of our study participants, and has been seen as a primary reason for practicing food taboos across the globe (1,2,4,112,125,139). Many of the specific health concerns reported by our participants have been described in other studies in Cambodia as experiences of *toa*. For instance, women in our study reported restricting foods to avoid diarrhea, stomach aches (6,106,110), weakness, headaches, vomiting (6,106), seizures (110), stiff backbone, jaw tightness, dry skin, and inadequate breastmilk production (106), which have all been previously associated in the literature with *toa*. Some of the health outcomes related to specific foods would be considered plausible through the

lens of Western medicine. For instance, types of fish, meats, and raw vegetables were avoided by some women because they feared becoming sick or getting various gastrointestinal illnesses. Improperly cooked animal foods and raw foods in Cambodia can present the risk of foodborne illness, and pregnant women are particularly at risk of being infected by foodborne pathogens (147).

Other food taboos observed in our sample had biologically implausible outcomes. For example, one participant avoided drinking coffee during pregnancy out of fear of getting diabetes, while other women eliminated pineapple, chili, porridge, and eggplant from their pregnancy diets to prevent getting “thick” amniotic fluid. Implausible outcomes such as these have been identified in other regions in Cambodia and throughout Southeast Asia. For example, in Thailand, shellfish and specific relishes are taboo during pregnancy since they are believed to “prevent the perineum from drying out properly after giving birth” and Thai eggplants are avoided out of fear of causing anal pain in women after delivery (148). In Laos, foods such as white buffalo, chicken meat, fermented fish, beef, and duck are avoided postpartum because they are believed to cause leprosy, and deer is avoided because it could cause the baby to lose consciousness (131). Healthcare providers should ensure that they engage in discussions with women during antenatal care visits surrounding health concerns for herself and her baby. Empowering women with knowledge regarding factors that can cause the symptoms or outcomes they aim to avoid (e.g., poor breastmilk supply, gastrointestinal illness) could help assuage the frequent health concerns reported by our participants.

Very few women reported that their dietary modifications were motivated by superstitious beliefs. Three women in our study reported fears related to taking up the characteristics of specific taboo foods: eel was avoided out of fear of “rolling like an eel”, *oxyeleotris marmorata* fish was avoided out of fear of getting dry skin like a fish, and coffee was avoided to prevent the baby from having dark skin. Concerns around exhibiting the characteristics of specific foods have also been reported in various focus group discussions across Southeast Asia: in Indonesia, some women avoided chicken eggs out of fear of “performing like a chicken” during labour, which was described to mean having a drawn-out labour (135); in Laos, specific ethnic groups avoid pumpkin after giving birth as it is believed to cause pumpkin-shaped abdomens in women (131); and in Malaysia, consuming porcupine during pregnancy is believed to cause raised blisters on the baby’s skin resembling porcupine quills (149). Further superstitious concerns are also commonly reported. In the same Indonesian study mentioned above, participants avoided jackfruit as it “could lead to the formation of a sticky layer of thick fat around the newborn” (135). In Thailand, some women avoid spicy foods since they may cause babies to be born hairless, and eating only half a banana is advised as eating a full banana could cause a birth obstruction (148). Similar concerns around birth obstruction have been reported in Malaysia, where pregnant women will only eat fish and wild animals caught using particular methods to prevent their babies from being trapped inside their bodies (149). Coconut, canned foods, plastic-covered foods, jackfruit, and cabbage are also avoided for this same reason (149). The lack of superstitious motivations and the prominence of health concerns reported by participants in Kampong Thom should be considered when developing approaches to address peripartum food taboos in Cambodia. Our findings suggest that rural Cambodian women could be receptive to various nutritional and health interventions that address their specific health concerns.

Women in our study did not generally describe which individuals helped guide their decisions to add or avoid foods in their diet. A small number of women stated that they made dietary changes because of the advice of elders, family members, community members, and doctors. None of the previous studies conducted in Cambodia appear to have examined where women obtained their information on foods to avoid in pregnancy and postpartum. An ethnographic study conducted in south-western Cambodia highlighted that participants primarily received advice on postpartum practices from their mothers and midwives (104). These women also viewed other family members, healthcare providers, and community elders as influential and trusted individuals (104). Another qualitative study with pregnant women in Preah Vihear, a province on Kampong Thom's northern border, found that women commonly source information from their family, husbands, and community elders (109). Elsewhere in Southeast Asia, women learn of food taboos through family members (133,136), ethnic groups (133), intergenerational knowledge, personal experiences, and the experiences of friends and neighbours (150). If a woman chooses to follow food taboos, it is essential for healthcare practitioners to enquire about the motivators for this decision. Such knowledge will support health workers in having meaningful discussions about dietary avoidances with their patients and help guide their interventions, as needed.

The variability in the rationale provided for each food avoided or added to the diet suggests that there is no unanimous understanding of the impacts of each food consumed in pregnancy and postpartum. This variability is particularly interesting for food taboos, as these are generally viewed as culturally motivated behaviours inherited from previous generations (1,112). Our study findings could indicate that the perceived outcomes from eating taboo foods may not stem from the understandings of the entire Khmer culture, but rather from smaller units such as a

woman's family or circle of influence. A more localized understanding of the impact of various foods could help explain the irregularity of foods avoided and added to the maternal diet, along with the lack of sociodemographic predictors for these behaviours. Of the three most avoided foods during pregnancy and postpartum, none of the reasons for avoiding these foods were shared by more than 50% of women. It was common for very specific reasons to be given by singular women. Better agreement was observed for the benefits of adding particular foods to the maternal diet. For all three most frequently added foods in pregnancy, providing energy to the mother was the main motivating factor for over 50% of women. The motivation to add specific foods to the maternal diet may come from women's lived experiences or generational knowledge. It has previously been highlighted that Cambodian women view adequate maternal diet as essential for supporting recovery and overall well-being after childbirth (104). Food additions may also be motivated by messaging shared through antenatal care visits: healthcare professionals advise women that having a healthy diet will help promote their levels of energy and strength (151).

6.5 Predictors of food avoidances and additions

During postpartum, the only factor associated with engaging in food avoidances was the number of live births a woman had experienced, with every additional birth reducing the odds of engaging in food taboos by 24%. This trend has been observed in Laos (133,137) and Malaysia (136), where gravidity was associated with a reduced likelihood of following a restrictive diet postpartum. Our study also revealed that every additional birth also reduced the odds of women intentionally adding foods to their diets by 20%. It is possible that multiparous women are less concerned with the risks of eating taboo foods or of not adhering to specific food additions in

their diet as they have already had a successful pregnancy, delivery, and postpartum experience, which can lead to reduced levels of fear or uncertainty with these periods of the lifecycle. In the neighbouring province of Siem Reap, Turner *et al.* observed that women used traditional medicines more frequently during their first pregnancy than during subsequent pregnancies, as women were more reliant on the advice of elders to guide them through this new experience. Once a woman has gone through a pregnancy, “she will have more confidence, knowledge, and experience so [she] ‘goes her own way’” in making these health decisions (110). The added confidence, knowledge, and experience gained through prior pregnancies may similarly impact a woman’s peripartum dietary decisions.

It is also possible that the lower amount of food additions observed in multiparous women is related to financial or time constraints, as engaging in some of the traditional postpartum practices can be costly. Purchasing firewood or charcoal for *ang pleung* alone is a significant expense for many women (106). During this same period, women must also have enough money to acquire special foods for her diet. Bazzano *et al.* identified that women who could not afford to purchase specialized postpartum foods simply continued to consume their typical diet (104). It is likely that these types of financial constraints more frequently affect households with multiple children, as the income in these households must sustain more people. Finally, the burden of acquiring and preparing special postpartum foods may present an additional barrier for women with other children in their care.

Intriguingly, none of the other sociodemographic or health variables assessed in our study were associated with following food taboos or food additions during pregnancy. Variables assessed

include women's age, annual household income, education, relative wealth status, having experienced a pregnancy loss, and the number of antenatal visits attended. While in Malaysia, maternal age, education, and household income were not associated with food avoidance in pregnancy (136), in Laos, studies have observed that women with higher socioeconomic status, higher education levels, who are older, and attend more antenatal care visits are less likely to have a restrictive diet (133). We hypothesized that experiencing a pregnancy loss would increase the odds of engaging in food avoidances and additions during pregnancy, but this was not observed. The lack of sociodemographic and health predictors for maternal dietary modifications makes it more difficult for healthcare practitioners and public health officials to identify groups of women who would benefit from additional nutritional and health counseling. As such, healthcare practitioners should ensure they discuss food taboos and dietary practices with all women during their antenatal care visits.

6.6 Strengths and limitations of study

This study provides the most in-depth analysis of maternal food taboos in Cambodia to date. A key strength of this study was its large sample size ($n=335$), which allowed us to gain knowledge on the dietary behaviours of numerous women across Kampong Thom. The use of open-ended questions to obtain information on foods taboos, food additions, and reasons for these behaviours is another strength, as it enabled us to capture the intricacies of the behaviours and beliefs of individual women. Assessing food additions alongside food taboos provided a broader picture of maternal dietary behaviours than if food taboos were assessed on their own. The longitudinal design of this study enabled data to be collected for four different timepoints, which helped highlight clear differences in dietary behaviours throughout the various peripartum phases.

Conducting the study in Kampong Thom can also be considered a strength for two reasons. First, Kampong Thom is a rural province, which is representative of the living situation of the vast majority of Cambodians (22). Food taboos have been seen to be more prevalent in rural regions than in urban regions in numerous studies (4,112). Therefore, there was a high likelihood that if food taboos were prevalent in Cambodia, they would be identifiable here. Also, it has been demonstrated that the dietary patterns in this centrally located province are generalizable to those in other rural regions of the country (17,18).

The main limitation of this study is the lack of comprehensive dietary intake data among study participants, which limits our ability to assess the nutritional impact of the documented dietary practices. Since we do not know the pre-pregnancy dietary intake of women, we cannot determine whether the reported modifications resulted in a nutrient profile that differs significantly from their normal patterns. It is possible that women reported avoiding foods during pregnancy and postpartum that were only included in their normal diet in limited quantities. For example, it is known that the typical Cambodian diet has relatively small quantities of meat (17), yet women frequently reported avoiding foods like beef, chicken, and buffalo meat. The nutritional impact of avoiding a food that is seldom eaten is very different than that of avoiding a food that is eaten daily. Additionally, we do not know if women replaced taboo foods by increasing the volume of foods already incorporated in their diet that were of similar nutritional value, as such actions are unlikely to have been reported by women as ‘food additions’. Future studies should use repeat 24-hour food recalls to gather more in-depth dietary information from women and minimize such ambiguities.

Additionally, some of the mixed dishes that women included or restricted in their diet, namely soups, lacked details on their specific ingredients. When this information was missing, we consulted the Cambodian members of the research team to identify those foods from a list of standard recipes developed in another project in Cambodia (152). These standard recipes may differ slightly from the actual ingredients used by study participants. This would impact the MDD-W food classification of a limited number of foods but would not affect the remainder of the findings. We were also unable to classify the traditional medicines used by participants as we did not have the ingredients used in these products, however we do not believe this omission would have a major impact on our participants' dietary intakes.

Finally, the use of long-term recall methods and the selected timepoints are other limitations of this study. Given that this study was a secondary analysis, data collection protocols were optimized for the objectives of the overarching thiamine study rather than for this analysis. Participants were asked to recall their dietary behaviours during pregnancy and between study visits. During their first visit at two weeks postpartum, women were asked about their dietary behaviours in the past two weeks, as well as during pregnancy. For the mid and late postpartum visits, women were asked about their behaviours since their last interview. Reliance on such long-term recall methods could lead to recall bias, and as such to missing data, as some women may forget which foods they avoided or intentionally included in their diet. Additionally, having ten to 12 weeks between study visits limited our ability to capture the evolution of peripartum food avoidances and additions. Previous studies in Southeast Asia suggest that women engage in different food taboos at two weeks and four weeks postpartum, and that most women return to a normal diet by 12 weeks postpartum (125,133,137,138). As such, it would be ideal to collect data

on dietary modifications at these postpartum timepoints and at eight weeks postpartum to observe changes in food taboos and additions. Women should also be asked about their intention for future dietary modifications, as some women in our study and others continue to engage in these behaviours beyond 12 weeks postpartum (132,133).

6.7 Recommendations for future research

Further research should be conducted on postpartum dietary practices of women in Cambodia. Our study indicates that food taboos are particularly prevalent during the first few weeks postpartum, therefore focus should be placed on this period. Future studies should conduct comprehensive dietary assessments for women at multiple timepoints, including pre-pregnancy, to better monitor the evolution of food taboos and additions. One potential outcome to examine in the future would be the impact of peripartum dietary changes on maternal dietary diversity, as was done in Laos by Smith *et al.* (133). This would help better assess if maternal dietary practices are beneficial or harmful to the nutritional intake of women. It would also be useful for future studies to directly examine the nutritional status and health outcome of both women and their children to assess if dietary behaviours in Cambodia are associated with these outcomes.

Future studies should be conducted in other rural and urban regions of Cambodia to assess whether the behaviours of women in Kampong Thom are reflected in other regions of the country, as dietary behaviours could change according to geographic location. It is possible that smaller, more isolated communities could have more cohesive approaches to food taboos and food additions. It would also be relevant to include Cambodians outside the Khmer ethnicity, such as Indigenous groups, to see if there are ethnic differences in maternal dietary practices.

Other factors that should be studied in relation to peripartum dietary modifications include a woman's religious affiliation, her level of interaction with older generations, as well as her level of independence in her health and nutrition decisions. All these factors have the potential to influence a woman's inclination to practice food taboos and to add specific foods to her peripartum diet.

Additionally, a woman's engagement in other cultural practices should be assessed in future studies. As described previously, health status in Cambodia is traditionally viewed as a balance between the body's state of 'hot' and 'cold' (3,104,106); pregnancy is considered a hot state, and postpartum, a cold state (3). *Ang pleung* (postpartum roasting) and heat injections are two methods used to heat the body during the first two weeks after giving birth (104). The timing of these two practices coincides with the highest period of food taboos for women in our study. Therefore, it is possible that some of the dietary practices observed in our study are influenced by a woman's belief in traditional Cambodian perspectives on health and her practice of *ang pleung* or heat injections. These factors could be potential predictors for a woman's engagement in food taboo and additions.

6.8 Recommendations for healthcare professionals and public health officials

Healthcare professionals providing antenatal care should be aware that food taboos are commonly practiced in early postpartum in rural regions of Cambodia. Overall, women should not be advised to stop engaging in food taboos, as these practices may help women feel a sense of control over the health of themselves and their child, and these practices can positively impact health. It is essential to discuss these food avoidances with women at antenatal visits. If women

choose to practice food avoidances, it would be important for healthcare professionals to assess potential nutritional and health impacts for each individual woman. Some women intentionally add foods to their diet at the same time as they are avoiding foods, which may already counterbalance the nutritional risk. If a risk is identified, healthcare professionals should work with women to identify nutritionally equivalent foods that could be added to her diet or consider supplementation if no nutritionally equivalent option is accessible.

Healthcare professionals should also discuss the use of traditional medicines with their patients. If patients choose to use these products, healthcare professionals should attempt to assess the potential health impact of these medicines to minimize the risk of negative health outcomes related to their use. It is also essential to ensure that patients are knowledgeable of specific signs and symptoms during pregnancy and postpartum that warrant urgent medical attention. For instance, vaginal bleeding, excessive vomiting, and higher fever could all be signs of a peripartum health emergency that would be safest to be addressed by a licensed health professional. Traditional medicines could be considered for concurrent use with biomedical treatment if situations like these arise.

Finally, public health officials should use the knowledge acquired through this study to develop or refine nutrition and health programs to support women through pregnancy and postpartum. Our study provides the necessary understanding of maternal dietary modifications, potential benefits and issues with current practices, and women's rationales for such practices. The study also reveals that maternal concerns related to health, inadequate breastmilk supply, and low levels of energy are common in this population. This information should be utilized to create

person-centered nutrition and health programs that can benefit pregnant and lactating women. To pursue a person-centered approach, public health officials should next conduct focus group discussions with relevant parties (e.g., pregnant and lactating women, grandparents, village elders) to generate ideas and receive feedback on how to optimize maternal diet and health during pregnancy and lactation (153). These consultations could highlight which of the current antenatal programs and messages are considered beneficial by the concerned parties and which could be tailored to best suit the community's needs. Engaging in a person-centered approach can improve the effectiveness of nutrition and health programs (153) and thereby enhance maternal and child health outcomes.

7.0 Conclusion

Food taboos during pregnancy and postpartum were practiced throughout Kampong Thom, yet were limited in duration and severity. While 71% of women avoided at least one food or beverage postpartum, most avoidances occurred in the first two weeks after women gave birth. Food taboos were far less prevalent during pregnancy, and many had the potential to confer positive health impacts through the avoidance of sugar-sweetened beverages, caffeine, and alcohol. A variety of nutritious foods, namely fish- and meat-based soups and soymilk, were also added to the diets of many pregnant and lactating women.

This study revealed discrepant dietary practices and beliefs among women in Cambodia. First, a wide breadth of foods were avoided and added to women's diets, with certain foods being considered harmful by some women and beneficial by others. Second, rationales for dietary modifications generally centered on supporting the health of women and their children, yet the health outcomes believed to be associated with specific foods varied between participants. Third, sociodemographic and health characteristics were found to have little influence on food avoidances or additions. These findings suggest that peripartum dietary practices are shaped less by a strict belief system within the Khmer culture, and more by individual or household understandings of food and health during pregnancy and lactation.

At a population level, peripartum food taboos do not appear to present a substantial risk to the health of women and children in Kampong Thom. However, at the individual level, we observed some potentially risky behaviours. A limited number of women avoided many foods throughout pregnancy and postpartum, and did not report specifically adding foods of similar nutritional

quality to their diets. These women may have difficulties meeting their nutritional requirements during these vulnerable periods of the lifecycle. The continued presence of food taboos in Cambodia warrants a deeper exploration of maternal dietary behaviours in pregnancy and lactation. Conducting comprehensive nutrition assessments in different regions across Cambodia will help better understand the nutritional impact of peripartum food taboos and additions. Public health officials and healthcare providers should continue to address food taboos in their messaging and interactions with women of reproductive age. The findings of this study can be used to inform the development of person-centered nutrition programs that will support the health of women and children in Cambodia.

8.0 References

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9.0 Appendices

Appendix A: National Ethics Committee for Health Research certificate of research ethics clearance

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|  ក្រសួងសុខាភិបាល MINISTRY OF HEALTH គណៈកម្មាធិការជាតិរ្រួមសីលធម៌ សម្រាប់ការស្រាវជ្រាវសុខភាពដែលពាក់ព័ន្ធនឹងមនុស្ស National Ethics Committee for Health Research  លេខ...../NECHR..... | ព្រះរាជាណាចក្រកម្ពុជា KINGDOM OF CAMBODIA ជាតិ សាសនា ព្រះមហាក្សត្រ NATION RELIGION KING  |
| រាជធានីភ្នំពេញ, ថ្ងៃទី.....០១.....ខែ.....០៤.....ឆ្នាំ២០១៨..... | |
| <p>Dr. Kyly Whitfield</p> <p>Project: Trial of thiamine supplementation in Cambodia. Version N° 1, dated 1st March 2018</p> <p>Reference: 26th April 2018 NECHR meeting minute</p> <p>Dear Dr. Kyly Whitfield,</p> <p>I am pleased to inform you that your study of the protocol entitled “Trial of thiamine supplementation in Cambodia. Version N° 1, dated 1st March 2018” has been approved by National Ethics Committee for Health Research (NECHR) in the meeting on 26th April 2018. This approval is valid for twelve months after the approval date.</p> <p>The Principal Investigator of the project shall submit following document to the committee’s secretariat at the National Institute of Public Health at #80 Samdach Penn Nouth Blvd, Sangkat Boeungkok2, Khan Tuol Kork, Phnom Penh. (Tel: 855-23-880345, Fax: 855-23-881949):</p> <ul style="list-style-type: none">• Annual progress report• Final scientific report• Patient/participant feedback (if any)• Analyzing serious adverse events report (if applicable) <p>The Principal Investigator should be aware that there might be site monitoring visits at any time from NECHR team during the project implementation and should provide full cooperation to the team.</p> <p>Regards,</p> <p>Chairman</p> <div style="text-align: center;"> Prof. ENG HUOT</div> | |

Appendix B: MSVU certificate of research ethics clearance



University Research Ethics
Board (UREB)

Certificate of Research Ethics Clearance

| | | | | |
|---|---|----------------------------------|---------------------------------------|--|
| <input checked="" type="checkbox"/> Clearance | <input type="checkbox"/> Secondary Data Clearance | <input type="checkbox"/> Renewal | <input type="checkbox"/> Modification | <input type="checkbox"/> Change to Study Personnel |
|---|---|----------------------------------|---------------------------------------|--|

| | | | |
|----------------|-----------------------|-------------|-----------------------|
| Effective Date | April 27, 2018 | Expiry Date | April 26, 2019 |
|----------------|-----------------------|-------------|-----------------------|

| | |
|-----------------------------|---|
| File #: | 2017-141 |
| Title of project: | Trial of thiamine supplementation in Cambodia |
| Researcher(s): | Kyly Whitfield |
| Supervisor (if applicable): | n/a |
| Co-Investigators: | n/a |
| Version : | 1 |

The University Research Ethics Board (UREB) has reviewed the above named research proposal and confirms that it respects the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* and Mount Saint Vincent University's policies, procedures and guidelines regarding the ethics of research involving human participants. This certificate of research ethics clearance is valid for a period of **one year** from the date of issue.

| Researchers are reminded of the following requirements: | |
|---|---|
| Changes to Protocol | Any changes to approved protocol must be reviewed <u>and</u> approved by the UREB prior to their implementation. Form: REB.FORM.002 Info: REB.SOP.113 Policy: REB.POL.003 |
| Changes to Research Personnel | Any changes to approved persons with access to research data must be reported to the UREB immediately. Form: REB.FORM.002 Info: REB.SOP.113 Policy: REB.POL.003 |
| Annual Renewal | Annual renewals are contingent upon an annual report submitted to the UREB prior to the expiry date as listed above. You may renew up to four times, at which point the file must be closed and a new application submitted for review. Form: REB.FORM.003 Info: REB.SOP.116 Policy: REB.POL.003 |
| Final Report | A final report is due on or before the expiry date. Form: REB.FORM.004 Info: REB.SOP.116 Policy: REB.POL.003 |
| Privacy Breach | Researchers must inform the UREB immediately and submit the Privacy Breach form. The breach will be investigated by the REB and the FOIPOP Officer. Form: REB.FORM.015 |
| Unanticipated Research Event | Researchers must inform the UREB immediately and submit a report to the UREB within seven (7) working days of the event. Form: REB.FORM.008 Info: REB.SOP.115 Policy: REB.POL.003 |
| Adverse Research Event | Researchers must inform the UREB immediately and submit a report to the UREB within two (2) working days of the event. Form: REB.FORM.007 Info: REB.SOP.114 Policy: REB.POL.003 |

*For more information: <http://www.msvu.ca/ethics>

Daniel Seguin, Chair
University Research Ethics Board

Halifax Nova Scotia B3M 2J6 Canada
Tel 902 457 6350 • msvu.ca/ethics

Appendix C: English version of consent form for the *Trial of Thiamine Supplementation in Cambodia*

Trial of thiamine supplementation in Cambodia
CONSENT FORM

| | |
|--------------------------------|--|
| Principal Investigator: | Kyly Whitfield , Department of Applied Human Nutrition, Mount Saint Vincent University |
| Co-Investigators: | Hou Kroeun , Helen Keller International Cambodia Keith Porter , Helen Keller International Cambodia Tim Green , South Australia Health and Medical Research Institute Frank Wieringa , Institut de recherche pour le développement Mam Borath , National Sub-Committee for Food Fortification, Ministry of Planning, Cambodia Prak Sophonneary , National Nutrition Program, Ministry of Health, Cambodia Jeff Measelle , Department of Psychology, University of Oregon Dare Baldwin , Department of Psychology, University of Oregon Geraldine Richmond , Presidential Chair in Science, University of Oregon |
| Contact | If you have questions you can ask the interviewer, or contact a Khmer speaking co-investigator, Hou Kroeun, at 089 956 199. |
| Site | Kampong Thom province, Cambodia |
| Granting Agency | Bill and Melinda Gates Foundation; Sackler Institute for Nutrition Science, New York Academy of Sciences |



Introduction

Thiamine, also known as vitamin B₁, is found in some foods. When we don't have enough thiamine we can develop a disease called beriberi. Beriberi is common in Southeast Asia because the dietary staple, rice, contains almost no thiamine. We recently found that up to three quarters of women and half of children in Cambodia had low levels of thiamine in their blood.

Babies usually develop beriberi when they are three months old. It can lead to heart problems and sometimes death. We've also recently learned that babies who don't eat enough thiamine can have trouble learning later in life, even if they don't have the symptoms of beriberi as a baby. If a mother doesn't eat enough thiamine, her milk is low in this vitamin, and the baby doesn't get enough thiamine. By giving more thiamine to mothers we hope to increase the amount of thiamine in her breast milk, preventing the disease in babies.

Adding thiamine to salt in the factory (fortification), in the same way that all salt currently contains iodine, may be a good way to prevent beriberi. Although we know that eating thiamine can prevent beriberi, we don't know how much thiamine mothers need to eat to ensure there is enough thiamine in their milk. Also, we don't know how much salt breastfeeding mothers in Cambodia usually eat. The purpose of this study is to determine the correct dose of thiamine required by mothers, and determine how much salt they usually eat. We also want to watch babies' milestones to determine if they are learning at the right pace.

Three hundred and twenty breastfeeding women in Kampong Thom will be invited to participate in this study. Women will be randomized (like flipping a coin) to one of four groups and take one pill each day for six months. Three groups will consume a thiamine supplement (1.2 mg/day, 2.4 mg/day, and 10 mg/day) and one group will have a placebo (no thiamine). We will also provide salt to your household to determine how much you usually eat.

Participation

Your participation in this study is entirely voluntary, so it is up to you to decide whether you would like to take part in this study. Before you decide, it is important for you to understand what the research involves. This consent form will tell you about the study, why the research is being done, what participation in the study will look like, and the possible benefits, risks, and discomforts.

If you wish to take part in the study, you will be asked to provide consent to the interviewer by stamping your thumbprint on this consent form. If you do decide to take part in this study, you are still free to withdraw at any time and without giving any reasons for your decision. If you do not wish to take part, you do not have to provide any reason for your decision not to participate.

Please take time to read the following information carefully and to discuss it with your family, friends, and Village Chief before you decide.

Who is conducting the study?

Researchers from the Department of Applied Human Nutrition at Mount Saint Vincent University in Canada are conducting this study in collaboration with Helen Keller International, Cambodia and a number of other researchers listed on the first page. You are entitled to request further details from the investigators. If you have questions you can ask the interviewer, or contact a Khmer speaking co-investigator, Hou Kroeun, at 089 956 199.

Who Can Participate?

In order to participate in this study, you must:

- be the mother of a newborn
- be between 18-45 years of age,
- have had a normal most recent pregnancy (i.e. no known chronic conditions, no preeclampsia, gestational diabetes etc), and your singleton infant must have been born without complications (e.g. low birth weight (<2.5 kg), tongue tie, cleft palate)
- intend to exclusively breastfeed for the first six months,
- reside in Kampong Thom province, Cambodia, and not be planning to move in the next six months,
- be willing to consume one pill daily from 2 weeks through 24 weeks postpartum,
- be willing for your entire household consume only salt provided by the study team, and,
- be willing for following biological samples to be collected: a maternal venous blood sample and breast milk sample at 2 weeks postpartum, a breast milk sample at 12 weeks postpartum, and maternal and infant blood samples and a breast milk sample at 24 weeks postpartum.

Who Should Not Participate in This Study?

You should **not** participate in this study if you:

- do not meet the criteria above,
- are currently participating in any nutrition programs beyond normal care,
are currently taking, or have taken any thiamine-containing supplements over the previous 4 months, or
are unable to provide informed consent.

What will participation in this study look like?

If you agree to participate in this research study, you will be asked to complete three study visits, one 2 weeks after delivery, and one each when your baby is 1, 3, and 6 months old. You will first be asked to complete a short questionnaire at your home, which should take about half an hour to complete. The questionnaire will ask questions about you, such as your age, and education level, as well as questions about the food you regularly eat. After you finish the survey in your home, we will measure your height and weight, and the length, weight, and head circumference of your baby. At each session, the researcher will interact with your baby to get a sense of his or her developmental progress. For example, the researcher will see how babies respond to sights and sounds and social interaction, and how

easily they move their bodies. Also, the researcher will ask you to interact with your baby in particular ways, such as trying to coax a smile, or encourage interest in a new toy; if you consent, these interactions will be videotaped to help us with scoring. The researcher will also ask you a range of questions about what you are observing about your baby's development. These activities will take about 45-50 minutes.

The next day you will be asked to travel to a central village location such as the Village Chief's home, where a trained phlebotomist will collect blood and breast milk samples so we can measure thiamine (vitamin B₁). The blood sample will involve having a needle poke to your inner elbow to collect half a tablespoon of blood. For the milk sample, we will use an electronic breast pump to collect a full breast expression from the breast you have not most recently fed from. Once we have taken these samples, we will randomize you (like flipping a coin) to one of four groups and ask you to take one pill each day. Three groups will consume a thiamine supplement (1.2 mg/day, 2.4 mg/day, or 10 mg/day) and one group will have a placebo (no thiamine). You will not know which supplement you are receiving. We will also provide salt to your household to determine how much you usually eat. Field staff will visit your home every two weeks to provide more salt as needed, to pick up used supplement packs, and deliver new supplements.

When your baby is 1 month old we will collect another breast milk sample. When your baby is 3 months old we will return to complete another questionnaire, cognitive assessments, conduct a non-invasive physical exam of your baby, and will collect another breast milk sample. This visit will take place in your home, and should take about an hour.

At the end of the study, when your baby is 6 months old, we will ask you to complete another questionnaire, take body measurements from you and your baby, and collect blood and breast milk samples from you, as well as a blood sample from your baby (we will collect less than a third of a tablespoon of blood). Again, we will conduct cognitive assessments and a physical exam.

Risks

The blood collection procedure may cause some discomfort and slight bruising or, very rarely, an infection at the site of the needle poke. After the blood draw you will immediately be given a bandage to cover the spot where the blood was taken.

Benefits

If you agree to take part in this study, there may or may not be a direct benefit to you. Three out of four women will be taking a pill that contains thiamine, but no one, not even the field staff, will know which pill is which until after the study is completed. All women participating in this study will receive a free 22-week supply of iodized salt for her entire household, and you can keep the salt container provided. At the end of the study we will return to your village to inform you of your thiamine status. Since we will need to be able to contact you by phone, you will receive a mobile phone as well as \$1/month in mobile credit during the study. You can feel free to keep this mobile phone after the study finishes.

We understand this survey will take some time away from your work and family, so after each study visit (2 weeks, 1 month, 3 months, and 6 months postpartum) we will provide you with a small gift (e.g. sarong, or laundry soap) to thank you for taking the time to participate.

Confidentiality

Your confidentiality will be respected. You will be assigned a unique study number as a participant in this study. This number will not include any personal information that could identify you (e.g., it will not include your initials, date of birth, etc.). Only this number will be used on any research-related information collected about you during the course of this study, so that your identity will be kept confidential. Information that contains your identity will remain only with the Principal Investigator and/or designate

All data from this study will be sent electronically from Cambodia to Canada in an encrypted file that requires a secret code to be accessed. Only members of the research team will know this code.

Participation and Withdrawal from this Study

Taking part in this study is voluntary. You may choose not to take part or may leave the study at any time and do not have to give a reason for your decision. If you decide not to take part or decide to leave the study, you may do so at any time without any consequences. All data collected about you up to the point of withdrawal will be retained for analysis. You will be given a copy of this signed and dated consent form. Throughout the study (at 1, 3, and 6 months) we will remind you about this visit and consent so that you remember that you are free to withdraw at any time and without giving any reasons for your decision.

What will information collected be used for?

All of the information collected from you and your child will be used to inform a future salt fortification program. We will measure thiamine in the blood and breast milk samples to determine the best dose of thiamine to give to future breastfeeding mothers to help prevent against beriberi. Information about how much salt you and your household usually eats will help us to formulate a recipe for thiamine-fortified salt. The cognitive assessments of your baby will help us understand how much thiamine babies need to develop normally.

Although the main purpose of this study is to understand thiamine and beriberi, if blood and breast milk samples remain after thiamine assessment, we will keep these samples in a freezer in Canada, and may analyze these samples for other nutrition-related research. These samples will only be labelled with the unique study ID, and will not be able to be traced back to you.

What happens after the study finishes?

We will return to your village after the study is complete to share the results of the study. If you want, we will also provide you with you and your baby's blood and breast milk results.

We may want to stay in touch with you and continue to follow your child and track his/her development. When you sign this consent form, the field staff person will ask you whether we can keep your contact information so we can be in touch about future research studies.

Trial of thiamine supplementation in Cambodia: Consent Form

- I have listened to, or read, and understood the information provided on this consent form.
- I have had sufficient time to consider the information provided and to ask for advice (if needed).
- I have had the opportunity to ask questions and have received a satisfactory response to my questions.
- I understand that all of the information collected will be kept confidential and that the results of this study will only be used for scientific objectives.
- I understand that participation in this study is voluntary and that I am completely free to refuse to participate or to withdraw from this study at any time without changing in any way the quality of care that I receive.
- I understand that I am not waiving any of my legal rights as a result of signing this consent form.
- I have listened to, or read, the information on this form and I freely consent to participate in this study.
- I have been told that I will receive a dated and signed copy of this form.

I consent to myself and my infant participating in this study.

Participant's name

Child's name

Do you give consent for videotaping? We will not distribute this video or use it for any commercial purpose.

_____ No. _____ Yes → Participant's thumbprint:

Can we keep your contact information to contact you about future studies? _____

Participant's thumbprint:

Date:_____

Name of person obtaining consent

Signature of person obtaining consent

Appendix D: Abridged baseline questionnaire

Trial of thiamine supplementation in Cambodia



BASELINE QUESTIONNAIRE

| MODULE 2: DEMOGRAPHIC INFORMATION | |
|--|--|
| 1. What is your date of birth? (DD/MM/YYYY) | __ __ / __ __ / __ __ __ __ |
| 2. How many pregnancies have you had? | __ |
| 3. How many live births have you had? | __ → if 1, code and skip to Q8 |
| 4. Have you attended school? | 1. Yes 2. No → code, then proceed to Q11 __ |
| 5. What is the highest level of school you attended? | 1. Primary school 2. Lower Secondary school 3. Upper Secondary school 4. Higher education __ |
| 6. Has your husband/partner attended school? | 1. Yes 2. No → code, then proceed to Q13 __ |
| 7. What is the highest level of schooling your husband/partner attended? | 1. Primary school 2. Lower Secondary school 3. Upper Secondary school 4. Higher education __ |
| 8. What is your occupation? | 1. Homemaker 2. Unemployed 3. Seller 4. Garment Factory 5. Farmer 6. other: _____ |
| 9. What was the income for your whole household in the past 12 months ? | US\$ _____ |

| MODULE 3: EQUITY INDEX | |
|---|--|
| 10. Does your household have electricity? | 1. Yes 2. No _____ |
| 11. Does your household have a television? | 1. Yes 2. No _____ |
| 12. Does your household have a refrigerator? | 1. Yes 2. No _____ |
| 13. Does your household have a CD / DVD player? | 1. Yes 2. No _____ |
| 14. Does your household have a wardrobe? | 1. Yes 2. No _____ |
| 15. Does your household have a generator / battery / solar panel? | 1. Yes 2. No _____ |
| 16. Does any member of your household own a motorcycle / scooter? | 1. Yes 2. No _____ |
| 17. Does any member of your household own a watch? | 1. Yes 2. No _____ |
| 18. Does any member of this household have a bank account? | 1. Yes 2. No _____ |
| OBSERVATION ONLY: What is the main material of the floor of the living house? 19. RECORD ONLY ONE OBSERVATION. | Natural floor: 1. Earth/sand 2. Dung Rudimentary Floor: 3. Bamboo/palm 4. Wood planks Finished floor: 5. Parquet or polished wood 6. Ceramic tiles 7. Cement 8. Carpet 99. Other – Specify _____ |
| OBSERVATION ONLY: What is the main material of the exterior walls of the living house? 20. RECORD ONLY ONE OBSERVATION | 0. No Walls Natural walls: 1. Earth/sand 2. Dung Rudimentary walls: 3. Bamboo/palm with mud 4. Stone with mud |

| | |
|--|---|
| | 5. Uncovered adobe 6. Plywood 7. Carboard 8. Resued wood Finished Walls: 9. Metal 10. Cement 11. Stone with lime / cement 12. Bricks 13. Cement blocks 14. Covered adobe 15. Wood planks / shingles 99. Other – Specify _____ |
| 21. What type of fuel does your household mainly use for cooking? | 1. Charcoal 2. Wood 3. Electricity 4. LPG (natural gas) 5. Biogas 6. Straw/shrubs/grass 7. Animal dung 99. Other – Specify _____ |
| What is the main source of drinking water during the rainy season for members of your household? 22. | 1. Piped into dwelling 2. Open well 3. Covered well 4. Drilled Borehole (with hand pump or other type of pumping system) 5. Surface water (e.g. spring, river/stream, pond/lake/dam) 6. Rainwater 7. Bottled water 99. Other – Specify: _____ |
| What kind of toilet facility do members of your household usually use? 23. ASK TO SEE. → if 0, record and skip to Q38. | 0. No facility—bush, field 1. Flush to piped sewer system (not shared with other households) 2. Flush to septic tank (not shared with other households) 3. Flush or pour toilet piped sewer system (shared with other households) 4. Flush or pour toilet to septic tank (shared with other households) 5. Traditional pit latrine 6. Ventilated Improved Pit (VIP) latrine 7. Pit latrine without slab 8. Composting toilet 9. Bucket 10. No permission to see |

| | |
|--|-------------------------------|
| | 99. Other – Specify: _____ |
| 24. Do you share this toilet facility with other households? | 1. Yes 2. No _____ |

| MODULE 4: MATERNAL FOOD INTAKE PATTERNS | | |
|---|---|--------|
| 25. Did you avoid eating certain foods/drinks in pregnancy? | 1. Yes 2. No → code, then proceed to Q40 _____ | |
| 26. If yes, which foods/drinks did you avoid eating/drinking in pregnancy, and why? | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| 27. Did you avoid eating certain foods/drinks in the postpartum period? | 1. Yes No → code, then proceed to Q42 _____ | |
| 28. If yes, which foods/drinks did you avoid eating/drinking in the postpartum period, and why? | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |

| | | |
|---|--|--------|
| | | |
| 29. Were there foods/drinks you specifically chose to eat/drink during pregnancy? | 1. Yes No → code, then proceed to Q44 _____ | |
| 30. If yes, which foods/drinks did you choose to eat/drink in pregnancy, and why? | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| 31. Were there foods/drinks you specifically chose to eat/drink during the postpartum period? | 1. Yes No → code, then proceed to Q46 _____ | |
| 32. If yes, which foods/drinks did you choose to eat/drink in the postpartum period, and why? | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |
| | Food/Drink | Reason |