Dietary factors and food preparation techniques related to iron absorption

- Knowledge and practice in the Kandal Province, Cambodia

Kostfaktorer och matlagningstekniker relaterade till järnabsorptionen

- Kunskaper och metoder i Kandalprovinsen, Kambodja

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ABSTRACT

Introduction Malnutrition and coexisting micronutrient deficiencies are common in the developing world. A high prevalence of anemia is found in Cambodia with children and women being the most affected. Anemia is defined as lack of red blood cells, resulting in impaired blood function and poor oxygen transport. Iron deficiency (ID) is often an underlying factor of anemia. Diet modifications to increase intake and absorption of iron can to some extent prevent iron deficiency anemia (IDA), which is often caused by lack of iron in the diet.

Objective The aim was to study knowledge and practice regarding food preparation techniques and dietary factors related to iron absorption in Kandal Province, Cambodia.

Method Structured interviews based on a written questionnaire consisting of 17 closed questions were conducted in eight villages in Kandal Province, Cambodia. A total of 143 questionnaires were collected for analysis. Chi-square tests were performed using SPSS 18.0 and the significance level was set to p<0.05.

Results The food habits showed lack of diversity. The diet was mainly rice based and red meat consumption was low. The majority used an iron pot for cooking, although not many knew that it could enhance the iron content in the food. The knowledge on bioavailability of iron appears to be limited. A significant correlation was found between those who had received information on iron and those who stated that red meat is a good source of iron(p=0.046).

Conclusion Knowledge on food preparation techniques, dietary sources of iron, stimulating- and inhibiting factors for iron absorption appears to be limited. Interventions including education on bioavailability and how to enhance the iron content in the diet are important and they should be adapted to the local community.
SAMMANFATTNING

**Bakgrund** I utvecklingsländer är malnutrition och brister på mikronutrienter vanligt förekommande. En hög prevalens av anemi kan ses i Kambodja, framförallt hos kvinnor och barn. Anemi definieras som otillräckligt med röda blodkroppar, vilket orsakar dålig syretransporterande förmåga och blodfunktion. En vanlig orsak till anemi är järnbrist, vilket ofta är en följd av lågt intag av järn i kosten. Förändringar i kosten som leder till ett ökat intag och en ökad absorption av järn kan till viss del förhindra järnbrist.

**Syfte** Att undersöka matlagningstekniker och kostfaktorer relaterade till järnabsorptionen samt kunskaper och vanor angående detta i Kandalprovinsen, Kambodja.

**Metod** Strukturerade intervjuer utfördes i åtta byar i Kandalprovinsen, Kambodja. Dessa baserades på en kvantitativ enkät bestående av 17 slutna frågor. Totalt samlades 143 enkäter in för analys i SPSS 18,0. Chi-väst test användes för att testa skillnader mellan grupper och signifikansnivån bestämdes till p < 0,05.

**Resultat** Måltidsmönstren visade på en ensidig konsumtion av livsmedel. Kosten var risbaserad och konsumtionen av rött kött var låg. Majoriteten av respondenterna tillagade sin mat i järngryta, däribland visste en liten andel att detta kunde höja järninnehållet i maten. Kunskaper om järnets biotillgänglighet tycks vara låga. Ett signifikant samband sågs mellan de som fått järninformation och de som valde rött kött som en god källa till järn (p=0,046).

**Slutsats** Kunskaperna om matlagningstekniker, goda källor till järn, stimulerande och hämmande faktorer för järnabsorptionen förefaller vara begränsade. Interventioner baserade på utbildning i hur man kan förbättra järninnehållet i kosten är av stor vikt och bör anpassas till respektive samhälle.
Table of content

1 Introduction ......................................................................................................................................... 5
   1.1 Malnutrition in developing countries .......................................................................................... 5
   1.2 Iron – an important micronutrient .............................................................................................. 5
   1.3 Iron deficiency and iron deficiency anemia ............................................................................... 6
   1.4 Cambodia ..................................................................................................................................... 6
   1.5 Interventions .............................................................................................................................. 6

2 Objective ........................................................................................................................................... 7

3 Method ............................................................................................................................................... 7
   3.1 Method ......................................................................................................................................... 7
   3.2 Sample ......................................................................................................................................... 7
   3.3 Design .......................................................................................................................................... 7
   3.4 Analysis ....................................................................................................................................... 8
   3.5 Ethical issues .............................................................................................................................. 8

4 Results ............................................................................................................................................... 8
   4.1 Food habits .................................................................................................................................. 10
   4.2 Food preparation techniques ...................................................................................................... 10
   4.3 Knowledge .................................................................................................................................. 11

5 Discussion ......................................................................................................................................... 13
   5.1 Method ....................................................................................................................................... 13
   5.2 Results ....................................................................................................................................... 14

6 Conclusion ......................................................................................................................................... 16

7 Authors contribution ......................................................................................................................... 16

8 Acknowledgements .......................................................................................................................... 16

References ............................................................................................................................................ 17

Appendix I. Questionnaire
Appendix II. Accompany letter
Appendix III. Meal patterns
1 INTRODUCTION

1.1 Malnutrition in developing countries

Nutritional deficiencies are common around the world and result in higher rates of morbidity and mortality, especially among children and women (1). Different factors can contribute to nutritional deficiencies, for example poverty and limited knowledge on appropriate nutrition. Food insecurity, meaning a limited access to nutritionally adequate and safe food, is another cause of nutritional deficiencies (2-3). The consequence of inadequate intake of nutrients is malnutrition/undernutrition (3). The risk of developing undernutrition is high when the intake is inadequate to meet the body’s daily needs and the nutritional stores are depleted. Children, especially in developing countries are most vulnerable to malnutrition (1). There are three main indicators of malnutrition in children; intrauterine growth restriction (IUGR), wasting and stunting. In 2005, 178 million children under five years of age were reported being stunted, 112 million being underweight and 55 million estimated to be wasted (4). Malnutrition among women in developing countries, particularly the nutritional status of mothers before, during and after pregnancy is also of great concern (5). During pregnancy proper nutrition is important in order to prevent IUGR and fetal death (4). Malnutrition can cause intellectual disabilities, less economic productivity and suboptimal reproductive performance, consequences which are highly unfavourable in developing countries (1). Signs of malnutrition can be seen at macro- and/or micronutrient level. Bhutta and Khan reported that the most common micronutrient deficiencies among women in developing countries are those of vitamin A, iodine, zinc and iron.

1.2 Iron – an important micronutrient

Iron is an essential mineral, which must be obtained from the diet (7). The iron homeostasis is well regulated by the absorption of iron in the small intestine (8). High doses of iron in its free form can be toxic (7) and, therefore, the fine tuning of its absorption is an important function, since the body is unable to excrete iron actively (8). There are two forms of iron in the diet, haem and non-haem iron. Haem iron exists in meat, poultry and fish and is well absorbed (9). Non-haem iron is present in plant-based foods, such as cereals, fruits and vegetables. Non-haem iron can exist in the ferric (Fe³⁺) or ferrous (Fe²⁺) form and is best absorbed as ferrous iron (10). Ferric iron can be reduced to the ferrous form by stomach acid and dietary ascorbic acid; hence a combined diet with both ascorbic acid and non-haem iron rich foods will benefit the absorption. Inhibiting factors for the absorption of non-haem iron can be phytate, polyphenols, tannins and calcium (3, 10).
1.3 Iron deficiency and iron deficiency anemia

Iron deficiency (ID) can develop when the iron requirements exceed the iron intake from the diet (11), usually due to inadequate dietary intake or blood loss (12). ID is often seen in developing countries where poverty rates are high and where it can be difficult to receive proper healthcare and treatment (13). ID is the most common cause of anemia and can develop into iron deficiency anemia (IDA) (11). When suffering from IDA there is not enough iron to form red blood cells (12). Effects of IDA can be suboptimal cognitive and psychomotor development in young children, decreased work-productivity and cognitive problems in adults (10, 14-15). Discussions are ongoing on the possible irreversible effect of early ID (16). Lack of iron during the first 6-12 months may alter the development of the central nervous system and affect neural functioning in adulthood. IDA in pregnant women has been identified as a cause for higher maternal mortality rates, low birth weight and prematurity (10). The intake of micronutrients of women in Asia is usually low (17).

1.4 Cambodia

Cambodia is one of the least developed countries in Southeast Asia and it has a high prevalence of malnutrition (18). Cambodia demographic and health survey from 2005 investigated the prevalence of anemia in Cambodia (19). They found that 62% of children between the age 6-59 months and 47% of women between the ages of 15-49 were anemic. In these figures other causes of anemia, such as lack of folate and B12, thalassemia, sickle-cell disease, malaria and intestinal worm infestation are included. However, the most common cause of IDA in developing countries is low bioavailability of iron in the diet (20). The Cambodian diet is rice-based and consists of refined foods low in iron (18). Meat (chicken, pork, beef) is not consumed on a daily basis (21). The high prevalence of IDA and the lack of variety in the Cambodian diet require interventions both on a large scale and on household level to prevent micronutrient deficiencies (18, 22).

1.5 Interventions

Many studies have examined diverse techniques to enhance the iron content in the diet at household level (13, 23). Adish et al. found lower frequency of IDA in children who consumed food cooked in iron pots (23). Education on how to reduce iron-inhibiting factors and increase the stimulating ones in the diet could be an intervention strategy (24). Zimmerman and Hurrell suggest different strategies to combat iron deficiency, such as education on how to improve the iron intake and its bioavailability through dietary modifications, dietary diversity or a combination of both (8). In order to have a good outcome from interventions and to enhance the level of knowledge, it is important to adapt the information to the local community.

This study was done in collaboration with The Center for Child and Adolescent Mental Health (Caritas-CCAMH) in Takhmau, Cambodia. CCAMH is a collaborative program between the Ministry of Health, Royal Government of Cambodia and Caritas Cambodia, an international non-governmental organization (NGO), operational since the year 1991 (25). The main objective of their program is to enhance the mental health and school staying power of the children and young people in Cambodia through community, school and center based intervention. The Caritas-CCAMH team works in 20 villages in Kandal province.
implementing comprehensive child development program and improving the nutritional status of the children is one of their goals.

2 OBJECTIVE

The aim was to study knowledge and practice regarding dietary factors and food preparation techniques related to iron absorption in Kandal Province, Cambodia.

3 METHOD

3.1 Method

A structured interview based on a written questionnaire (Appendix I) was chosen as the instrument for this quantitative study in order to reach out to a large population and collect data representative for the Kandal Province. Structured interviews were used due to lack of reading ability in the targeted villages. The interviews were conducted with the assistance of staff from CCAMH during the village visits in Kandal Province, Cambodia.

3.2 Sample

The aim was to select both men and women in eight villages in Kandal Province in Cambodia. Respondents between the age of 15 and 65 were included in the study as this is usually the group involved in cooking. Convenience samples were collected in eight villages, four villages where CCAMH community based program is currently operational (labelled old CCAMH) and four where the CCAMH team plans to work in the future (labelled new CCAMH). The selection was made in collaboration with CCAMH, as they were conducting a baseline survey in these villages. This resulted in the same respondents being targeted for this study.

3.3 Design

During August 2011, the study was conducted in Kandal province, Cambodia. The questionnaire consisted of 17 questions (the majority multiple choice); six concerning knowledge about iron, five background questions, four about food habits and two regarding food preparation techniques. Closed questions were used in order to avoid misunderstandings and misinterpretations by the interviewers and respondents and to avoid the need for further translation of the answered questionnaire. The questionnaire as well as the accompanying letter (Appendix II) was translated into Khmer. Field testing of the questionnaire among ten respondents, both staff and clients at CCAMH, was followed by adjustments to make it more suitable for the target population. The structured interviews were carried out in the homes of the respondents, with the help of five Cambodian psychology students, who happened to volunteer at CCAMH. Clear instructions were given to the interviewers on the importance of “informed consent”, that was informing the respondents the purpose of the study and the participation being voluntary. In addition, they were also given time to practice how to administer the questionnaire in order to prevent adding or excluding any details. Informal conversations with the staff at CCAMH, as well as observations on daily living in the area were performed.
A total of 144 questionnaires were answered, but one was excluded because two respondents answered the same questionnaire. Thus 143 questionnaires were collected for analysis. Three individuals had missing data on one question each, but not on the same one.

3.4 Analysis

Data was analyzed with SPSS 18.0. Chi-square tests were used to test differences between groups and the significance level was set to $p < 0.05$.

3.5 Ethical issues

The interviewers used the content in the accompanying letter to explain the purpose of the study and give a brief presentation of the authors. The respondents were informed of the participation being voluntary and that they would remain anonymous. To further ensure their anonymity the questionnaires were not coded individually, only colour coded as new or old village. Informed consent was sought from each individual prior to the structured interview. The village leaders also had to give their permission for submitting the questionnaires in their villages.

4 RESULTS

Totally, 143 questionnaires were analyzed. Of the respondents, 87% were women and 13% were men. The most common age-range was 26–35 (Table 1). More than half (54%) originated from the new CCAMH villages and 46% from the old. The majority (86 %) was responsible for cooking in the household. Seventy-nine respondents (55%) had been given information about iron content in food and the proportion between the old and new CCAMH villages were approximately the same. Everyone except two respondents wanted to know more about iron contents in food.
Table 1: Background factors of participants from old and new CCAMH village, Kandal Province, Cambodia, 2011

<table>
<thead>
<tr>
<th></th>
<th>Old CCAMH village n (%)</th>
<th>New CCAMH village n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>66 (46%)</td>
<td>77 (54%)</td>
<td>143 (100%)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-25</td>
<td>14 (22%)</td>
<td>8 (10%)</td>
<td>16 %</td>
</tr>
<tr>
<td>26-35</td>
<td>19 (29%)</td>
<td>24 (31%)</td>
<td>30 %</td>
</tr>
<tr>
<td>36-45</td>
<td>9 (14%)</td>
<td>29 (38%)</td>
<td>27 %</td>
</tr>
<tr>
<td>46-55</td>
<td>15 (23%)</td>
<td>11 (14%)</td>
<td>18 %</td>
</tr>
<tr>
<td>56-65</td>
<td>8 (12%)</td>
<td>5 (7%)</td>
<td>9 %</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woman</td>
<td>58 (88%)</td>
<td>66 (87%)</td>
<td>87%</td>
</tr>
<tr>
<td>Man</td>
<td>8 (12%)</td>
<td>10 (13%)</td>
<td>13%</td>
</tr>
<tr>
<td>Have received</td>
<td>39 (59%)</td>
<td>40 (52%)</td>
<td>55%</td>
</tr>
<tr>
<td>information on iron</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsible for</td>
<td>54 (83%)</td>
<td>68 (88%)</td>
<td>86%</td>
</tr>
<tr>
<td>cooking</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Those who had received information on iron contents in food (n=79) reported different sources of information through a multiple choice question (Figure 1). The sources reported in the two villages were different, however media and health center were frequently chosen in both groups. In the old villages, school and CCAMH had been sources of information, but not in the new one. An issue raised by one of the interviewers after their first interview was the fact that one woman had stated that she had received information on iron supplements, not iron as a nutritional factor, from the midwife during pregnancy. It is not known what kind of information is included from the different sources.
Figure 1: Sources of information on iron content in food in the different villages, Kandal province, Cambodia, 2011

4.1 Food habits

The selection of food was similar for breakfast, lunch and dinner (Appendix III). Rice/rice porridge was reported being usually consumed in all three main meals. Nearly everyone (99%) reported that rice/rice porridge was usually a part of their dinner. Observations revealed that white rice was the type commonly consumed. Other food items frequently consumed were fish, dark green leaf vegetables, red meat and egg. The percentage reporting that they usually ate red meat for lunch and dinner was the same (68%) and 45% included red meat in their breakfast. Fifty-four participants (38%) reported eating red meat at all three meals. Food items rarely consumed were chocolate/Milo, milk/yoghurt and coffee. No questions were included on the amounts consumed. In conversations with the staff at the CCAMH different aspects on the meat intake were discussed. Based on their own experiences there are problems with obtaining a proper amount of food, especially meat products. When observing the daily life in this area, noted were the small portion sizes and the even smaller amounts of meat. Different types of fruits and vegetables were observed at the local market in the urban area. Observed factors limiting the access of certain foods seem to be poverty, seasonal agriculture and difficulties in food transportation.

The most common frequency of red meat consumption was three to four times per week (43%). Almost half (42%) reported eating red meat twice a week or less, whilst 28% reported an intake of five times or more per week. There was no relationship between meat consumption and information received regarding iron content in food (p = 0.555).

4.2 Food preparation techniques

Iron pots were most frequently used in the household (88%). Aluminium- and stainless steel pots were used to a lesser extent. Almost a third (30%) thought that cooking in iron pot can enhance the iron content in foods and 59% stated that they did not know the answer to this
question. When examining the relationship between those who had received information on iron content in food and those who cooked in iron pot, no significant correlation was found (p = 0.839).

4.3 Knowledge

According to the respondents good sources of iron are dark green leaf vegetables (86 %), fish (52%), rice (39%), red meat (37%), fruit (32%) and chicken/duck/bird (31%). Eight percent reported that they did not know what a good source of iron is. None of the respondents chose exclusively the four right answers (red meat, fish, dark green leaf vegetables and chicken/duck/bird). The majority of the respondents (80%) chose dark green leaf as a factor increasing iron absorption in the body and 11% reported not knowing. More than half of the group (59%) did not know which factors reduce the iron absorption. Separate questions on knowledge were compared between the old and new CCAMH villages. Table 2 presents the correct answers and the percentage of respondents choosing them village-wise. The alternatives don’t know and none are not presented in Table 2. There was a small difference in knowledge between the villages, but it was not significant.

Table 2: Knowledge about good sources of iron, increasing and reducing factors based on multiple choice questions, Kandal Province, Cambodia, 2011

<table>
<thead>
<tr>
<th>Village</th>
<th>Good source</th>
<th>Increase uptake</th>
<th>Reduce uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes/no</td>
<td>Correct answer (%)</td>
<td>Yes/no</td>
</tr>
<tr>
<td></td>
<td>Old n=59</td>
<td>New n=72</td>
<td>Old n=57</td>
</tr>
<tr>
<td>Red meat</td>
<td>Yes 32</td>
<td>42</td>
<td>Yes 56</td>
</tr>
<tr>
<td>Fish</td>
<td>Yes 50</td>
<td>53</td>
<td>Yes 47</td>
</tr>
<tr>
<td>Dark green leaf</td>
<td>Yes 86</td>
<td>86</td>
<td>No 23</td>
</tr>
<tr>
<td>Rice</td>
<td>No 68</td>
<td>56</td>
<td>No 64</td>
</tr>
<tr>
<td>Coffee</td>
<td>No 99</td>
<td>95</td>
<td>No 94</td>
</tr>
<tr>
<td>Citrus fruit</td>
<td>No 86</td>
<td>77</td>
<td>Yes 14</td>
</tr>
<tr>
<td>Potato</td>
<td>No 83</td>
<td>73</td>
<td>No 83</td>
</tr>
<tr>
<td>White bread</td>
<td>No 99</td>
<td>88</td>
<td>No 91</td>
</tr>
<tr>
<td>Chicken/duck/bird</td>
<td>Yes 23</td>
<td>38</td>
<td>Yes 33</td>
</tr>
<tr>
<td>Noodle</td>
<td>No 97</td>
<td>84</td>
<td>No 86</td>
</tr>
<tr>
<td>Tea</td>
<td>No 100</td>
<td>91</td>
<td>No 97</td>
</tr>
<tr>
<td>Fruit</td>
<td>No 73</td>
<td>64</td>
<td>No 62</td>
</tr>
<tr>
<td>Chocolate/milo</td>
<td>No 94</td>
<td>92</td>
<td>No 99</td>
</tr>
<tr>
<td>Milk/yoghurt</td>
<td>No 86</td>
<td>77</td>
<td>No 82</td>
</tr>
</tbody>
</table>
More people in the group which had received information mentioned red meat as good source of iron (Figure 2, p = 0.046).

![Bar chart showing the relationship between receiving information on iron and choosing red meat as a good source of iron, Kandal province, Cambodia, 2011.](chart)

**Figure 2:** *Relationship between receiving information on iron and choosing red meat as a good source of iron, Kandal province, Cambodia, 2011*

Table 3 displays the correct statements on benefits of good iron status in the body and the percentage of correct answers. One third checked all the boxes except don’t know in this question. When asked about consequences of iron deficiency, tiredness, anemia, breathlessness and night blindness were the alternatives most frequently filled in.

**Table 3:** *Knowledge about benefits of good iron status in the body, Kandal Province, Cambodia, 2011.*

<table>
<thead>
<tr>
<th>Statement</th>
<th>Right/wrong</th>
<th>Correct answer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevent anemia</td>
<td>Right</td>
<td>87%</td>
</tr>
<tr>
<td>Better night vision</td>
<td>Wrong</td>
<td>32%</td>
</tr>
<tr>
<td>Improve oxygen transport</td>
<td>Right</td>
<td>62%</td>
</tr>
<tr>
<td>Prevent tiredness</td>
<td>Right</td>
<td>75%</td>
</tr>
<tr>
<td>Prevent goitre</td>
<td>Wrong</td>
<td>43%</td>
</tr>
<tr>
<td>Normal growth</td>
<td>Right</td>
<td>71%</td>
</tr>
<tr>
<td>Most important mineral in the bone</td>
<td>Wrong</td>
<td>36%</td>
</tr>
</tbody>
</table>
5 DISCUSSION

5.1 Method

The quantitative study method was chosen, as the objective was to examine the general knowledge among a wider population. Attitudes and opinions were not supposed to be examined, which made a quantitative approach more suitable. The fact that a high number of questionnaires were answered justifies the chosen method. The instrument gave the opportunity to explore food habits and food preparation techniques in a simple and concise manner. As the questionnaires were administered in several villages in Kandal province, we could cover diverse areas and habitants, giving a more nuanced sample.

The questionnaire was designed to examine several aspects of iron as a nutritional factor, from food habits and preparation techniques to common knowledge. Studies have shown that small measures can increase the iron content in the diet (23), why the questions on food preparation techniques and bioavailability were included in the instrument. Field testing the questionnaire ensured that the questions were appropriate, examining the right things, thus increasing the validity. The questions were discussed in detail with the interviewers, followed by role play to ensure high quality interviews. An independent back translation into English might have improved the validity of the questionnaire. The authors could not objectively review the translation as the study-limitations did not allow back translation. However, revisiting and revising the instrument after field testing made the questionnaire user friendly and applicable to the community, with appropriate choices of words and expressions, enabling the objective of the study. Local food habits are different from those in Sweden and this was kept in mind when developing the questionnaire. For example is the way fish consumption in Cambodia differs from that in Sweden, as the whole fish is eaten, which improves the micronutrient intake (26). Fish was therefore included as a good source of iron. Food items appropriate for Cambodia was listed with the help of native Khmer (Cambodian) staff at the CCAMH.

In retrospect, a few questions could have been composed slightly different. The questions about food habits during breakfast, lunch and dinner presumes the respondents eating all the three meals as there are no checkbox for not having either breakfast, lunch or dinner. None of these could be marked but that does not mean the same as not eating the meal. In the question regarding intake of red meat there should have been a checkbox for not eating meat at all. It might have been of value to find out in which meal/meals meat was consumed (Appendix I, question 5.1). The knowledge questions (Appendix I, questions 3.1-3.3, 7.1-7.2) might have been easier to analyze if each alternative had been given the options of yes, no and don’t know. By avoiding open questions because of the language barrier some information could not be obtained, for example it would have been interesting to find out if any other sources of iron information existed than those given as options.

As the method used was a structured interview it resulted in a greater population being examined. The use of a self administered questionnaire would have introduced bias, as only the educated (and in this sense literate) could take part in the study. At the same time a structured interview gives a number of things to reflect upon (27). For example if respondents could not remember all the given alternatives. Pictures of food items could have simplified them answering the questionnaire. With better reading and writing abilities, a self-administered questionnaire could reduce the possibility of interviewer-bias. The relationship between the interviewers and the respondents and our presence at the time of the interviews is
an issue to be considered. In our study, the interviewers came from different parts of Cambodia, and did not know the respondents beforehand. The presence of the authors could have influenced the respondents in the background of perceived unequal position of power arising from difference in educational level and a sense of hierarchy towards people from developed economies. On the other hand, lack of local language skills on our part, could have made the respondent more secure during the interview. A source of error regarding the interviewers include the possibility of them not reading the questions properly, having their own opinions inflicting the respondents and/or the presence of social differences between the interviewers and the interviewees.

5.2 Results

The large proportion of women answering was not entirely surprising as the study was conducted in their homes during daytime and culturally women are considered having more involvement in cooking. “Building food-based approaches around the needs and activities of women can be especially effective. This is particularly important in recognition of the multiple roles women play as food providers and primary caregivers” (22). The above citation suggests that this study benefited from having a large proportion of women participating. The fact that most of the respondents were responsible for cooking was also of value for the study, as they influence the eating patterns of the entire family and subsequently their iron intake and practice.

A positive result was that more than half of the respondents already had received information on iron content in food. The types of reported information sources did not differ much between the two types of villages, with the exception of information from school and CCAMH in the old villages. This is most likely due to CCAMH team working in these villages and also having a school based community programme. The credibility of the information from the different sources could be questioned. For example media was reported as one common source. This is of concern as messages regarding nutrition can be presented by media in different ways, leading to misinformation and misinterpretation. Due to the language barrier it was not possible for us to assess the types of messages presented in media and therefore conclude if the information was valid. Nor could we explore the type of media available to the population. The report Iron deficiency anaemia assessment, prevention and control, states that iron supplementation programs are common both in developed and underdeveloped countries (22, s. 65). During one interview, a woman stated she had received information on iron supplementation during pregnancy. It raises the question whether the received information deals with the nutritional aspect of iron or only mentions iron as a supplement.

The results indicate that the diet in the targeted villages is rice based which is consistent with other studies (18). The rice consumed is refined and its iron content is low (7). Other than rice, four iron containing items (fish, dark green leaf vegetables, red meat, egg) were reported frequently consumed. We believe that these four food items in adequate amounts could be important parts of a balanced diet. The high rates of IDA in Cambodia (19), may suggest that these items are not consumed as often as stated in the interviews. The high rate of malnutrition in Cambodia (18) also suggests that in many cases the overall food intake is low and subsequently the intake of micronutrients. In our study 38% reported usually having red meat in all their meals (breakfast, lunch, dinner), which is inconsistent with previous research on food habits and intake of meat (21). The most common reported frequency of red meat
consumption was three to four times per week and the remaining responses were coupled into two groups; twice a week or less and five times per week or more. The proportion of people having meat twice a week or less (42%) was higher than those with a more frequent consumption of five times or more per week (28%), therefore it seems unlikely that 38% usually ate red meat three times per day. Under- and/or over-reporting should also be considered, as it is a common phenomenon in studies on food habits (28). Just as “healthy foods” can be over-reported in Sweden, we assume that the red meat consumption could be overestimated in Cambodia, due to it being an expensive food item. A factor making the results hard to value is the lack of information on amounts consumed. Other sources of error could be recall-bias related to questions on food habits or the term “usually” being misinterpreted. The access to foods could probably reflect the intake of certain food items and in the rural areas the access of some items appears to be limited. A number of factors underlie this assumption; poverty, lack of knowledge on nutrition, limited agriculture and difficulties in food transportations. We consider that these factors could cause lack of diversity in the diet of the respondents and also be an underlying cause of anemia in Cambodia.

A high number of respondents used iron pots when cooking, although only 30% believed that this could enhance the iron contents in the food. This indicates that cooking in iron pot is largely based on tradition and access, not on knowledge. The fact that iron pot contains the word iron might lead them to think that this is the correct answer. It can be argued if they knew for sure the material of their utensils. Since there was no difference between those who received information on iron content in food and those who cooked in iron pot, it can be discussed if food preparation techniques are included in the information given on iron content in food. We believe the population in Kandal province should be encouraged to cook all the possible meals in an iron pot, on the basis of it being a food preparation technique which can enhance the iron content in the diet (7).

Those who had received information on iron content in food were more likely to choose red meat as a good source of iron, however this connection did not exist between receiving information and the consumption of red meat. This might imply that iron information contains some facts about what a good source of iron is and that there is other factors involved in the consumption of meat, such as food insecurity. When analyzing the question concerning good sources, some difficulties were met. As this was a multiple choice question with both right and wrong answers, the correct being four items (red meat, fish, chicken/duck/bird, dark green leaf vegetables), it was of interest if anyone had chosen all these four. No one marked the four right answers exclusively, which could imply that they were merely guessing or that they actually knew some of them, but not all.

Zimmermann and Hurrell raise the importance of having knowledge on factors affecting bioavailability of iron in the diet (8). The data in our study suggests that the knowledge on bioavailability; inhibiting and stimulating factors for iron absorption is low. However, when analyzing specific variables, around 50% stated that red meat and fish can increase the iron absorption in the diet. Only 18% chose citrus fruit, which is considered a potent enhancer (10). This type of fruits was present in Kandal province, although we can not determine their accessibility in the rural area. Almost 80% marked dark green leaf vegetables as a stimulating factor; at the same time they chose the same food item to be a good source of iron. Dark green leaf vegetables are not a stimulating factor for iron absorption and the above result may be due to the question being misinterpreted. The relatively high proportion of those not knowing the inhibiting factors was another sign of the limited knowledge on bioavailability. In societies where IDA is common and food insecurity rates are high it is important to promote
simple measures of enhancing iron in the diet (22), which could be achieved through educational interventions. There seems to be no difference in knowledge level among the two types of villages, which leads us to believe that the information given was not focused on iron as a micronutrient. More information on iron needs to be given in all villages. It would be of interest to compare them in the future if interventions on iron intake and knowledge are conducted separately in the two types of villages. Our opinion is since there is a high prevalence of IDA and malnutrition in this area, more interventions should be focused on nutrition and iron.

Many respondents marked the following as benefits of good iron status in the body: prevent anemia, improve oxygen transport, prevent tiredness and normal growth. However knowledge on benefits of good iron status was hard to determine since a third marked all the possible alternatives, both right and wrong, which indicates knowledge is limited. This is further strengthened by better night vision being commonly marked as a benefit of good iron status in the body and night blindness being frequently chosen as a consequence of ID, two states that are related to vitamin A and not to iron.

6 CONCLUSION

The food habits in the targeted villages showed lack of dietary diversity which can be multifactorial and can cause nutritional deficiencies. Knowledge on food preparation techniques, good sources of iron, stimulating- and inhibiting factors for iron absorption appears to be limited. It is relevant to highlight the importance of using simple measures for enhancing the intake of iron. Interventions should target the different aspects of iron intake such as bioavailability, food preparation and food choices. In order to maximise the outcome, the interventions should be adapted both to the individual and the local community.

7 AUTHORS CONTRIBUTION

Ida Berge and Evelina Dahl have planned the study, finalized the questionnaire and accompanying letter. The data was processed and analyzed together, as was the writing of the essay.

8 ACKNOWLEDGEMENTS

First of all we would like to thank the entire staff at the CCAMH for their hospitality. We want to send many thanks to the specific group helping us with translation and revision of the questionnaire and the five psychology students who conducted the interviews. A special thank to Dr Bhoomikumar Jegannathan who has helped us through the entire process.
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Knowledge on food preparation techniques and dietary factors to increase the content
of iron in the diet, among the people of Cambodia.

1. ក្រុមចំនួន៖ ស្តីពីបញ្ហារបស់ក្នុងប្រកបដោយប្រព័ន្ធនាពេក (Put a cross the check boxes suitable for you)
   1.1  □ ស្រី (Woman)  □ បុំបង (Man)
   1.2 អាយុ (Age)
       □ ១៨-២៩ (15-25 years old)  □ ២០-៣៩ (26-35 years old)  □ ៣០-៤៩ (36-45 years old)
       □ ៥០-៦៩ (46-55 years old)  □ ៦០-៧៩ (56-65 years old)
   1.3 បានបង្កើតពីឈ្មោះទូទៅអ្នកបានបង្កើតប្រព័ន្ធនាពេកខាងលើ? (Are you responsible for the cooking in your household?)
       □ ៣០/៣០ (Yes)  □ ៣០ (No)

2.1 បង្កើតប្រព័ន្ធនាពេកក្នុងប្រយោគប្រភេទសម្រាប់តូចអាចរីរាងប្រព័ន្ធនាពេកប្រយាប់ខ្លាំង

   ជើងស្ពោរ? ក្រុមចំនួន៖ ឈ្មោះបីដំបូង (Which of these food items is usually a part of your breakfast? More than one item can be chosen)
       □ សាច់អាហារ (Red meat (cow, pig))  □ សាច់អាហារ, កង្រោត, កង្រោត... (Chicken, duck, bird...)
       □ ស្រែ (Fish)  □ ស្រែ (Egg)
       □ គ្រីស្រែស្វាយ (Dark green leaf vegetable)
       □ ឈើ/ឈើ្ (Rice/porridge)  □ ឈើ/ឈើ្, ឈើ្ិី (Noodle-Chinese and Khmer)
       □ កាត់ (Coffee)  □ កាត់ (Tea)
       □ ស្តារ (Citrus fruits (orange, lemon))  □ ស្តារ, ស្រែស្វាយ, ផ្កាវ (Fruit, i.e., Banana, mango)
       □ ស្រែស្វាយ (Potato)  □ ស្រែស្វាយ/ឈើ្ិី (Chocolate/Milo)
       □ ឈើ្ិី (White bread)  □ ឈើ្ិី/ឈើ្ិី (Milk, yoghurt)
       □ ឈើ្/ឈើ្/ឈើ្ិី (None of these)

2.2 បង្កើតប្រព័ន្ធនាពេកក្នុងប្រយោគប្រភេទសម្រាប់អាវធ្វើ (Which of these food items is usually a part of your lunch? More than one item can be chosen)
       □ សាច់អាហារ (Red meat (cow, pig))  □ សាច់អាហារ, កង្រោត, កង្រោត... (Chicken, duck, bird...)
       □ ស្រែ (Fish)  □ ស្រែ (Egg)
APPENDIX I (2/5)

2.3 Which of these food items is usually a part of your dinner? More than one item can be chosen.

- Red meat (cow, pig)
- Egg
- Dark green leaf vegetable
- Noodle-Chinese and Khmer food
- Tea
- Orange, mango, banana
- Chocolate/Milo
- White bread
- None of these

3.1 Which of these is a good source of iron? More than one item can be chosen.

- Red meat (cow, pig)
- Egg
- Dark green leaf vegetable
- Noodle-Chinese and Khmer food
- Tea
- Orange, mango, banana
- Chocolate/Milo
- White bread
- None of these
- Don't know

3.2 Which of these could increase the iron uptake in the body? More than one item can be chosen.

- Red meat (cow, pig)
- Egg
- Dark green leaf vegetable

Theory, Research, Iron, Ques26-7-11
3.3 Which of these could reduce the iron uptake in the body? More than one item can be chosen.

- **Red meat (cow, pig)**
- **Chicken, duck, bird**
- **Dark green leaf vegetable**
- **Noodle-Chinese and Khmer**

4.1 What kind of pot is usually used for cooking in your household? More than one item can be chosen.

- **Stainless steel pot**
- **Clay pot**
- **None of these**

4.2 Which of these can, when cooked in, enhance the iron content of foods?

- **Stainless steel pot**
- **Clay pot**
- **None of these**

5.1 How often do you usually eat red meat in your main meal?

- **Less than once a week**
- **Once a week**
- **3-4 times per week**
- **5-6 times per week**
- **Everyday, one meal**
6.1 Have you received any information regarding iron contents in food?
☐ Yes ☐ No
(If Yes continue to 6.2)

6.2 From whom/which sources? More than one can be chosen.
☐ Government (CCAMH) ☐ Health center
☐ Family/friends ☐ School
☐ Media, newspapers, etc. ☐ Others

7.1 Given below are some statements (both right and wrong) about benefits of good iron status in the body. Choose the right answers. More than one can be chosen.
☐ Prevents anemia ☐ Better vision
☐ Improve oxygen transportation in the body ☐ Is the most important mineral in the bone
☐ Prevents tiredness ☐ Prevents goiter
☐ Normal growth ☐ Don’t know

7.2. Given below are some statements (both right and wrong) about consequences of iron deficiency. Choose the right answers. More than one can be chosen.
☐ Coughing ☐ Night blindness
☐ Tiredness ☐ Concentration problem
☐ Dehydration ☐ Breathlessness
☐ Anemia ☐ Don’t know
8.1 ការបញ្ចូលត្រឹមត្រូវប្រក锭ូតូវទ្រពយការពារសុខភាព សុំសកម្តជាតិរបស់អ្នក? (Would you like to know more about iron contents in food?)
☐ បាន/Yes ☐ ទោស/No
APPENDIX II (1/1)

(Knowledge on food preparation techniques and dietary factors to increase the content of iron in the diet, among the people of Cambodia)

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In order for us to collect data were are in much need of your help. We are administering our questionnaire to men and women, over the age of fifteen, in Kandal province. Participation is of course voluntary, however it is of great value for the quality of this study if you would like to share your experiences with us. With your information we could get a better understanding of your country and culture. Your answers will be handled confidentially and you will remain anonymous. Our data will be analyzed in a statistical programme and after the completion of the analysis the questionnaires will be destroyed. Feel free to contact us if you have any questions!)