Original article

Factors associated with complementary feeding practices among children aged 6-23 months in Malawi: an analysis of the Demographic and Health Survey 2015-2016.

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Abstract

Background: Optimal child complementary feeding practices are crucial for nutritional status, growth, development, health, and, ultimately, affect child survival. This is the first population-based study in Malawi that aimed to examine factors associated with complementary feeding practices among children aged 6-23 months.

Methods: Utilizing data from the 2015-16 Malawi Demographic and Health Survey (MDHS), 4,732 children aged 6–23 months and their mothers were analyzed. The MDHS produced a nationally representative sample using a multistage cluster sampling design which included sampling weights. The impact of child-, maternal-, household-, community- and health service utilization- factors on complementary feeding practices was examined using the generalized estimating equation logistic regression.

Results: After controlling for a wide range of covariates, children from mothers with secondary or post-secondary education, and from mothers working in agriculture and living in the central region, were significantly more likely to have timely introduction to solid, semi-solid or soft food. Surprisingly, being over one year of age was associated with reduced odds of achieving minimum meal frequency. In addition, children over one year of age, from mothers older than 24 years, and from mothers with primary, secondary and post-secondary education were significantly more likely to achieve minimum dietary diversity. Children from rich households were more likely to achieve both minimum dietary diversity and minimum acceptable diet. Finally, exposure to mass media was significantly associated with increased odds of achieving minimum meal frequency, minimum dietary diversity and minimum acceptable diet.

Conclusions: Public health strategies aimed at reducing childhood undernutrition should focus on children from poor households, whose mothers have no formal education, and are unemployed. In addition, exposure to mass media had a positive impact on the three complementary feeding indicators. Therefore, behavior change communication messages, through mass media, aimed at promoting child nutrition are necessary to achieve optimal child complementary feeding practices.

Keywords: Complementary feeding indicators, risk factors, infant nutrition, Malnutrition, Malawi

Introduction

Optimal child complementary feeding practices are crucial for the nutritional status, growth, development, health, and, ultimately, affect child survival.[1,2] Complementary feeding is defined as the process of initiating the baby other foods and liquids, along with breast milk when breast milk alone is no longer adequate to meet the nutritional requirements of infants.[3] Thus, the World Health Organization (WHO) established guidelines with respect to the infant and young child feeding (IYCF) practices for children aged 6–23 months. These guidelines considered the introduction of solid, semi-solid or soft food, minimum dietary diversity, minimum meal frequency, and minimum acceptable diet and consumption of iron-rich or iron-fortified foods as some of the eight core indicators for assessing IYCF.[4] The transition period from exclusive breastfeeding to 2 years is a critical window for optimal growth and development of the child. Therefore, appropriate, safe, adequately nourished and frequent feeding is essential during this period.[5,6] It is well-documented that children who are poorly fed during the period of growth spurt are at an increased risk of being malnourished.[7] Undernutrition is a major contributor of global under-five morbidity and mortality and it accounts for about 45% of all childhood mortalities.[8] In addition, undernutrition has been associated with compromised child's immunity, and brain development issues that lead to delayed motor and cognitive development.[7]

Globally, only a few children are timely introduced to solid, semi-solid or soft food and receive nutritionally adequate, acceptable, and diversified foods.[9] In many countries, less than one-fourth of infants aged 6–23 months are reported to meet the criteria for dietary diversity and feeding frequency that are appropriate for their age.[9] Prior research has demonstrated that children who are introduced to solid, semi-solid or soft food before 6 months as well as those who do not receive sufficient dietary diversity, meal frequency and adequate diet after 6 months of age become stunted, develop micronutrient deficiencies, and have common childhood illnesses.[7] Therefore, complementary feeding practice ought to be diverse of adequate energy density, and introduced at the right time in order to meet the growing needs of infants and young children. Previous studies have reported that factors such as, age of the child, [5] employment status of parents, [5] mother's marital status, [10] mother's educational attainment, [5,9] household monthly income/ wealth, [6,9,11] mother's knowledge/education,[9] number of children whose age is five years and under in the household, [6] exposure to media, [6,11] geographical region and maternal health-seeking behavior [11] have influence on child complementary feeding practices.

In Malawi, malnutrition rates among infants and young children have consistently remained high over the past two decades. In 1992, the Malawi Demographic and Health Survey (MDHS), reported that 48.7%, 27.2% and 5.4% of under-five children were stunted, underweight and wasted, respectively.[12] Similar trends of high levels of childhood malnutrition were reported between 2000 and 2014.[13,14] As at 2015-16, the prevalence of undernutrition was observed to remain unacceptably high (37.1%, 11.7%, and 2.7%) for being stunted, underweight and wasted, respectively,[15] indicating that undernutrition is a chronic public health problem in Malawi that needs urgent attention. The

United Nations Children's Fund (UNICEF), states that the immediate cause of undernutrition is a result of low or lack of dietary intake and recurrent infections.[16]

Despite that the Malawi government implemented a number of interventions since early 2000's to guide and improve the levels of child complementary feeding practices [17] a large proportion of children under two years still lack nutritionally adequate and diversified foods.[15] The 2016 Malawi Demographic Health Survey (MDHS) revealed that 25% of breastfed children had an adequately diverse diet and had been given foods from the appropriate number of food groups, while 29% had been fed the minimum number of times appropriate for their age in Malawi. In addition, only 8% of children aged 6–23 months met the minimum standards for all three child complementary feeding practices.[15] These percentages are low and there is need to scale up optimal child complementary feeding practices in Malawi.

Despite that previous studies have assessed child complementary feeding practice in Malawi, [18,19] these studies did not use nationally representative samples. Furthermore, there are limited studies that have assessed the newly introduced WHO complementary feeding indicators.[20] Thus, using a nationally representative sample, we aimed to examine the factors associated with the introduction of solid, semi-solid or soft food, minimum dietary diversity, minimum meal frequency, and minimum acceptable diet among children aged 6–23 in Malawi. The findings of the study will provide evidence to programme managers and policymakers to design and implement effective complementary feeding interventions. Specifically, the findings will help to address the levels of inadequate meal frequency, inadequate dietary and poor dietary diversity practices and ultimately, reduce the high prevalence of childhood malnutrition in Malawi.

Materials and methods

Study area

The study covered all the 3 administrative regions of Malawi (Northern, Central and Southern regions). Malawi is a sub-Saharan African country located south of the equator. It is bordered to the north and northeast by the United Republic of Tanzania; to the east, south, and southwest by the People's Republic of Mozambique; and to the west and northwest by the Republic of Zambia.[21] The economy of Malawi is based primarily on agriculture, and it accounts for about 30 percent of the gross domestic product (GDP).[22]

The study data, design, and sampling

This was a cross-sectional study which utilized the 2015-16 Malawi Demographic and Health Survey (MDHS) data. Malawi Population and Housing Census (MPHC), conducted in 2008, was used as the sampling frame for the MDHS survey. Comprehensive methods for the survey have been published elsewhere.[15] Briefly, the 2015-16 MDHS employed a two-stage probability sampling in the three regions of Malawi and produced a nationally representative sample. In the first stage, 850 standard enumeration areas (SEAs), including 173 SEAs in urban areas and 677 in rural areas, were selected with probability proportional to the SEA size and with independent selection in each sampling stratum. In the second, 30 households per urban cluster and 33 per rural cluster were selected with an equal probability systematic selection method.

Data collection and study sample

Data were collected from women aged 15–49 years with children below the age of 5 years prior to the survey using face–to–face interviews. In the interviewed households, 24,562 of the 25,146 eligible women were interviewed representing a 98% response rate.[15] Information on sociodemographic and IYCF practices was collected via verbal reports. Data on IYCF practices were collected using a 24-hour recall method; i.e. mothers were asked to recall all foods and liquids consumed by children in the day or night before the interview.[23] We restricted our analysis to the last born children, currently living with the respondent, and aged 6–23 months.[4] Figure 1 shows sample inclusion criteria.

Measures

Dependent variables

Four outcome variables were considered in this study namely: introduction of solid, semi-solid, or soft foods (yes/no), minimum meal frequency (yes/no), minimum dietary diversity (yes/no), and minimum acceptable diet (yes/no). Introduction of solid, semi-solid, or soft foods was defined as the proportion of infants 6–8 months of age who received solid, semi-solid, or soft foods in the previous day or night.[4] Minimum meal frequency was defined as the proportion of breastfed and non-breastfed children 6–23 months of age who receive solid, semi-solid, or soft foods (but also including milk feeds for nonbreastfed children). Minimum frequency was defined as: twice for breastfed infants 6–8 months, three times for breastfed children 9–23 months, and four times for non-breastfed children 6–23 months.[4] Minimum dietary diversity was defined as the proportion of children 6–23 months of age who receive foods from 4 or more food groups in the 24-hour recall period. The food groups in the MDHS were regrouped to be consistent line with the WHO recommended seven food groups used in defining children's minimum dietary diversity indicator as follows: (i) grains, roots, and tubers; (ii) legumes and nuts; (iii) dairy products; (iv) flesh foods (meats/fish/poultry); (v) eggs; (vi) vitamin A-rich fruits and vegetables; and (vii) other fruits and vegetables.[4] Minimum dietary diversity was calculated by summing up the reported number of food groups consumed in the 24-hour recall period. Minimum acceptable diet was defined as the proportion of children 6–23 months of age who receive a minimum acceptable diet (apart from breast milk). This composite indicator was calculated from the following two fractions; (1) breastfed children 6–23 months of age who had at least the minimum dietary diversity and the minimum meal frequency during the previous day divided by breastfed children 6–23 months of age, (2) non-breastfed children 6–23 months of age who received at least 2 milk feedings and had at least the minimum dietary diversity not including milk feeds and the minimum meal frequency during the previous day divided by non-breastfed children 6–23 months of age.[4]

Independent variables

A number of covariates were considered in this current study which included child-, maternal-, household- and community and health service utilization- factors. Child characteristics included sex of the child (male or female); the age of the child (6–11 months, 12–17 months, and 18–23 months); and perceived birth size (very small/smaller than average, average, and very large/larger than average). Women's characteristics were maternal age (15–24 years, 25–34 years, and 35–49 years); maternal education levels (no formal education, primary education, and secondary and post-secondary education); marital status (unmarried versus married); parity (1, 2, 3, and 4); maternal occupation (no employment, agriculture, and non-Agriculture); exposure to mass media was measured by access to newspapers, radio, and television. Respondents who had access to any of the three were considered to have media exposure (yes/no); religion (Roman Catholic, Protestant and Muslim and others); ethnicity (Chewa, Tumbuka, Lomwe, Yao, Ngoni, and others). Household characteristics included household wealth (poorest, poorer, middle, richer, and richest). The household wealth index is a composite measure of a household's cumulative living standard and was calculated using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles. Household asset scores were generated through a principal component analysis. The resulting asset scores were standardized and categorized into quintiles.[24] Other household factors were the household size (<5 versus ≥ 5), the number of under-five children in the household (≤ 1, 2, and ≥ 3); sex of the household (male versus female). Community-level characteristics included (place of residence (urban versus rural) and geographical region (northern, central, and southern). Health service utilization factors included vitamin A supplementation in the last six months (no versus yes); place of delivery (non-health facility versus health facility); the number of antenatal (ANC) visits during pregnancy (inadequate versus adequate) according to WHO recommendations,[21] and baby postnatal check within 2 months (no versus yes).

Statistical analysis

All analyses were performed using Stata statistical software version 15 (Stata Corp., College Station, TX, USA). The "svy" (survey) command was applied to take into account the complex survey design of the MDHS (i.e. to adjust for the clustering, and sample weights). Frequencies of study characteristics were reported as percentages with their 95% confidence intervals (CI). Using the Pearson chi-square, the bivariate analysis was performed to test the differences in distribution between groups (introduction of solid, semi-solid, or soft foods (yes/no) minimum meal frequency (yes/no), minimum dietary diversity (yes/no), minimum acceptable diet (yes/no)). All variables that showed significance at $p \leq 0.25$ in the bivariable analyses were fitted into the final models of the regression analyses. The multivariable analyses were conducted using a series of logistic regression models fitting the generalized estimating equations (GEE) for estimating the effects of predictors on the outcomes after controlling for confounding factors. Due to the hierarchical structure of the dataset, the GEE was used to adjust for possible correlated individual responses.[25] In the GEE models, sampling weights were applied. The results of the multivariate were presented as Adjusted Odds Ratio (AOR) with their corresponding 95% CI. Variables with *P*–values less than 0.05 were considered as statistically significant.

Ethics statement

The survey protocol was reviewed and approved by the Malawi Health Sciences Research Committee, the Institutional Review Board of International Classification of Functioning (ICF) Macro. However, the present study obtained approval from ICF Macro to analyze the data as such, no further ethical consideration was required. The data is publicly available at http://dhsprogram.com/data/available-datasets.cfm and can be obtained for free upon request.

Results

Sample characteristics

A total of 4,732 children age 6–23 months were analyzed in this current study. Figure 1 displays sample inclusion and exclusion criteria. A majority of children (85%) had been timely introduced to solid, semi-solid and soft foods. Furthermore, 29.8% of children had achieved minimum meal frequency, 24.9% had achieved minimum dietary diversity, whilst 8.3% had achieved minimum acceptable diet. Table 1 reveals the socio-demographic characteristics of the study participants.

Table 2 shows the percentage of food intake among children aged 6–23 months according to food groups consumed the previous 24 hours. About 70% of children were fed with grains, roots, and tubers, whilst 26% of children were fed with legumes and nuts. Few children (8%) were fed with dairy products whilst 33% of children consumed with flesh foods. Furthermore, nearly 12% of children consumed eggs, 48% vitamin A-rich fruits and vegetables and about 68% consumed other fruits and vegetables. The distribution of participants' characteristics according to the four outcomes is shown in table 3.

Factors associated with complementary feeding practices among children 6-59months

Introduction of solid, semi-solid or soft food

Table 4 displays the results of multivariable logistic regression. Children whose mothers had secondary and post-secondary education had increased odds of being timely introduced to solid food, semi-solid food or soft food (adjusted odds ratio [aOR] 2.46; 95% confidence interval [CI]:1.12–5.39)) compared to those whose mothers had no formal education. Further, children whose mothers had agricultural employment (aOR 2.65; 95% CI:1.59–4.43) and resided in the central region (AOR 2.84; 95% CI: 1.17–6.90) had increased odds of being timely introduced to solid food, semi-solid food or soft food compared to children whose mothers were not employed and resided in the northern region, respectively.

Minimum meal frequency

Children aged 12–17 months and 18–23 months were 33% (AOR 0.67; 95% CI: 0.55–0.80) and 44% (AOR 0.56; 95%: 0.46–0.68) less likely to achieving minimum meal frequency respectively compared to children aged between 6 and 11 months. However, the higher odds of achieving minimum meal frequency was observed in children whose mothers had exposure to mass media (aOR 1.31; 95% CI: 1.11–1.56) compared to those who were not exposed to mass media.

Minimum dietary diversity

Children aged 12–17 and 18–23 - months age groups were 1.90- (aOR 1.90; 95% CI: 1.54–2.40) and 2.30 (aOR 2.30; 95% CI: 1.82–2.91) – times more likely to receive minimum dietary diversity compared to children aged 6–11 months. Similarly, higher odds of receiving adequate dietary diversity were observed among children whose mothers had primary education (aOR 1.65; 95% CI: 1.20–2.27) and secondary and post-secondary education (aOR 1.67; 95% CI: 1.14–2.45), were in non-agricultural employment (aOR 1.78; 95% CI: 1.39–2.26) compared to children whose mothers had no formal education and were unemployed, respectively.

Furthermore, higher odds of receiving minimum dietary diversity were observed among children whose mothers were aged 25–34 years (aOR 1.53; 95% CI: 1.17–1.20) and 35–49 years (aOR 1.56; 95% CI: 1.08–2.25) compared to children whose mothers were younger than 25 years old. Compared to children whose mothers were not exposed to mass media, children whose mothers were exposed to media exposure were more likely to achieve minimum dietary diversity (aOR 1.37; 95% CI: 1.14–1.65). Children who resided in richest households, (aOR 1.37; 95% CI: 1.14–1.65) received vitamin A supplements in the last six months (aOR 1.23; 95% CI: 1.03–1.48), had postnatal check within 2 months (aOR 1.24; 95% CI: 1.01–1.51) and resided in central region (aOR 1.59; 95% CI: 1.09–2.32) were more likely to receive the recommended minimum dietary diversity compared to their respective counterparts. Reduced odds of achieving minimum dietary diversity were observed in children whose mothers' parity was 3 (aOR 0.67; 95% CI: 0.47–0.94) and 4+ (aOR 0.52; 95% CI: 0.36–0.75) compared to children whose mother had only one child.

Minimum acceptable diet

Lastly, children who had average birth sizes (aOR: 1.64; 95% CI: 1.11–2.42), and resided in richest households (aOR: 2.27; 95% CI: 1.37–3.78) and whose mothers had satisfactory media exposure (aOR: 2.08; 95% CI: 1.61–2.69) had higher odds of achieving minimum acceptable diet as compared to their respective counterparts.

Discussions

To our knowledge, this study is one of the first population-based studies to investigate the factors associated with complementary feeding practice (introduction of solid, semi-solid and soft foods, minimum dietary diversity, minimum meal frequency, and minimum acceptable diet) in Malawi. The results demonstrate that there is an array of sociodemographic and health-factors associated with complementary feeding in Malawi. Specifically, children from women aged 25–49 years and who had primary and post-primary education had increased odds of achieving minimum dietary diversity. Similarly, children whose mothers were exposed to media, resided in richest households and used PNC services had increased odds of meeting minimum dietary diversity. Surprisingly, children older than 12 months were less likely to meet the minimum meal frequency.

The proportion of children aged 6–23 months who received the recommended minimum meal frequency, minimum dietary diversity, minimum acceptable diet and introduction of solid, semi-solid or soft food was 29.8%, 24.9%, 8.4%, and 84.8% respectively. Low prevalence was observed for minimum meal frequency, minimum dietary diversity, and minimum acceptable dietary. These results suggest that complementary feeding practices remain a challenge in Malawi. Hence, studies to understand factors affecting complementary feeding practices are warranted, and this paper contributes to that knowledge.

The present study found that children born from older women, with secondary and post-secondary education, women working in the agriculture sector and women from the central region, had higher odds of being timely introduced to solid, semi-solid or soft foods to their children. The findings are consistent with previous studies.[26] The possible reason might be that education is directly linked to women's autonomy, changes in traditional beliefs, and women's control over household resources.[27] Hence, educated mothers are more likely to understand complementary feeding practices information provided through health and nutritional programs.[28] Children whose mothers were in agriculture employment had higher odds of being timely introduced to solid food, semi-solid or soft food probably due to the availability and use of adequate food the women harvested from their farms. Malawi's central region has the highest percentage of employed women who are largely working in agriculture.[15] Consequently, this may explain why children from central region were more likely to have timely introduction of solid, semi-solid or soft foods. Women who work in agriculture might have had easy access to different groups of food and possibly this may have an influence on complementary feeding practices.

Consistent with studies conducted in Ethiopia,[6] India,[29] Ghana,[30] Tanzania,[31] and Sri Lanka,[32], the current study also found that children aged 12–23 months had higher odds of meeting minimum dietary diversity implying that the practice of minimum dietary diversity increases as the age of children increases. Further, consistent with a study conducted in northwest, Ethiopia,[7] children whose mothers were older than 24 years were more likely to achieve minimum dietary diversity. Older mothers are more likely to be experienced and have knowledge on how to raise their children as compared to younger women. As expected, children whose mothers had primary education or secondary and post-secondary education were more likely to achieve minimum dietary diversity owing to the fact that educated women are more likely to have access to quality health services and messages which they may easily comprehend and apply.[33] Children whose mothers were working in the non-agricultural sector were more likely to achieve minimum dietary diversity as compared to children born to non-working women. The possible explanation is that women with formal employment may be in a better socioeconomic position to achieve food security which in turn may influence their complementary feeding practices.[26] Therefore, it is not surprising that even children from middle, richer or richest households were more likely to achieve minimum dietary diversity. Children from richest households might be fed with recommended diversified foods as their families are more likely to achieve food security as compared to children from a poor households.[9] In addition, higher parity was associated with reduced odds of achieving minimum dietary diversity. The underlying mechanism could be that, women with fewer children may commit themselves to taking care of their child and feed them appropriately with respect to complementary feeding practice, as compared to those with more children.[34] In addition, women with fewer children may have increased love and care including feeding practices for their children.[34] In line with prior studies,[35] we also found that children who had received vitamin A supplements in the last 6 months and whose mothers had PNC check within 2 months had increased odds of achieving minimum dietary diversity. These factors might underline women’s health-seeking behavior and the value they place on their health as well as that of their children.[36] In addition, PNC has proven to be a good platform to improve mothers’ knowledge and change unfavorable attitude towards implementation of appropriate child feeding practices.[37] Prior studies have reported that these positive effects mainly operate through child feeding counseling and behavioral change and communication interventions provided by health professionals.[38]

Surprisingly, children aged 12 months and above were less likely to achieve minimum meal frequency. This is inconsistent with studies conducted in Ethiopian, [34,39] Ghana [30] and other countries in Asia.[32,40] The reasons why older children are less like to meet the minimum number of meal frequency are poorly understood. However, the possible explanation might be that when children grow, they are more likely to be given little attention as compared to when they were younger. This may eventually result in failure to achieve minimum meal frequency as the children grow. However, there is need for further research to understand this finding.

In terms of minimum acceptable diet, children with perceived average birth size were more likely to achieve minimum acceptable diet as compared to those perceived to have very small birth size. Previous studies have indicated that birth sizes may reflect overall maternal health status as well as socioeconomic status.[41] Moreover, children from poorer, middle, richer and richest households were more likely to achieve minimum acceptable diet as compared to children from the poorest households. This finding emphasizes the role of socioeconomic status on child feeding practices. Households with high socioeconomic status are more likely to be food secure thereby, they afford to provide the minimum acceptable diet to their children.[42,43]

The finding of media exposure having an association with minimum meal frequency, minimum dietary diversity and minimum acceptable diet practices is consistent with previous studies.[6,39] Media is usually considered as a credible source of health and nutrition information hence such messages are more likely to be adopted.[44] Thus mothers who are exposed to mass media may acquire important information regarding complementary feeding practices.

Policy implication

The current study highlights the important factors influencing child complementary feeding practices in Malawi. Policy makers in nutritional projects should ensure that an integrated approach with other sectors, such as education, is adopted as this study has revealed the significance of maternal education in child complementary feeding practices. Further, our results revealed that use of healthcare services such as PNC influenced complementary feeding practices. Child nutrition programs planners should focus on younger women, with low uptake of such health care services to effectively improve child complementary feeding practices. Efforts should also be focused on developing relatively poor households in order to give the households an opportunity to achieve food security. Lastly, mass media is essential in delivering important child feeding messages thereby imparting the necessary knowledge to mothers. Therefore, programs aiming to improve child feeding practices should consider utilizing mass media. However, simultaneous efforts should be made to make mass media available to underprivileged households in order to increase the exposure.

Strengths and Limitations of the study

The present study was able to identify a wide range of determinants on the four components of complementary feeding practices in Malawi and it provides important insights by which the most appropriate interventions can be designed. The results can be generalized in Malawian context due to the use of a nationally representative sample. However, the results should be considered in light of several limitations. Firstly, the cross-sectional nature of the study design limits our ability to draw causal inferences between the covariates and the outcome variables. Secondly, the use of secondary data limited us to include other variables that could explain our outcome variables. Thirdly, as the study considered only 24-hour recall method, it might not accurately reflect participants past feeding dietary habit. Lastly, there might be a recall bias, and being a self-reported study might not give the exact figure of the minimum dietary diversity practice.

Conclusions

In the context of Malawi, our findings clearly demonstrate that a large proportion of children under the age of two years are missing out on the three indicators of complementary feeding practices indicators namely minimum dietary diversity, minimum meal frequency, and minimum acceptable diet. However, these findings show that most of the factors included in this study had a better prediction on the minimum dietary diversity than the other three outcomes. Hence, future studies should explore more of the other three indicators. Overall, the age of the child, mother's age, mother's education, mother's occupation, media exposure, parity, household wealth, vitamin A in the last 6 months, postnatal check within 2 months and region were associated with these components of complementary feeding practices. Identifying further determinants would help policy makers to focus on improved and effective behavior change, communication, as well as improved child complementary feeding practices through micronutrient supplementation, food security, health care utilization, and improved socioeconomic status.

Conflicts of interest: There is no potential conflict of interest.

Authors' contributions: PAMN, TGM, and ON contributed to the conception and design of the study. PAMN acquired data. PAMN and ON conducted analysis and interpreted results. PANM drafted the first article. ON and TGM revised the draft critically for important intellectual content. PAMN, ON, and TGM reviewed and approved the final version of the manuscript.

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Table 1. Socio-demographic characteristics of the study participants MDHS, 2015 - 2016 (n=4732)

	Frequency	Percentage	
	*n**	%*	95% (CI)
Child characteristics			
Sex of the child			
Male	2400	50.72	(49.06–52.37)
Female	2332	49.28	(47.63–50.94)
Age of the child (months)			
6-11	1648	34.82	(33.13–36.55)
12-17	1601	33.83	(32.19–35.51)
18-23	1483	31.35	(29.76–32.97)
Perceived birth size			
Very small	715	11.12	(13.69–16.66)
Average	2395	50.61	(48.66–52.56)
Very large	1632	34.27	(32.46–36.13)
Maternal characteristics			
Maternal age (years)			
15-24	2079	43.94	(42.07–45.81)
25-34	1900	40.15	(38.37–41.97)
35-49	753	15.91	(14.64–17.27)
Maternal education levels			
No formal education	554	11.71	(10.36–13.21)
Primary	3180	67.20	(65.17–69.18)
Secondary and above	998	21.09	(19.08–23.24)
Marital status			
Unmarried	785	16.60	(15.25–18.04)
Married	3947	84.40	(81.96–84.75)
Parity			
1	1264	26.71	(25.09–28.39)
2	856	20.22	(18.92–21.57)
3	766	16.19	(15.04–17.41)
4+	1746	36.89	(34.99–38.82)
Maternal occupation			
No employment	1438	30.40	(28.14–32.75)
Agricultural	2111	44.61	(42.06–47.20)
Non-Agricultural	1183	24.99	(22.86–27.25)
Media exposure			
No	3151	66.59	(64.64–68.49)
Yes	1581	33.41	(31.51–35.35)
Religion			
Catholic	850	17.98	(16.21–19.89)
Protestant	981	20.73	(18.84–22.76)
Muslim & others	2932	61.29	(58.75–63.78)

Ethnicity			
Chewa	1662	35.13	(39.92–38.48)
Tumbuka	404	8.55	(7.06–10.31)
Lomwe	803	16.97	(15.00–19.14)
Yao	768	16.23	(13.64–19.21)
Ngoni	825	11.11	(9.31–13.19)
Others	568	12.01	(10.48–13.74)
Religion			
Roman Catholic	850	17.98	(16.21–19.89)
Protestant	981	20.73	(18.83–22.76)
Muslim and others	2901	61.29	(58.75–63.78)
Household characteristics			
Household wealth			
Poorest	1208	25.53	(23.68–27.48)
Poorer	1090	23.02	(21.46–24.67)
Middle	921	19.46	(18.02–20.99)
Richer	785	16.59	(15.21–18.07)
Richest	728	15.39	(13.29–17.75)
Household size			
<5	1824	38.54	(36.65–40.46)
≥5	2908	61.46	(59.54–63.35)
Number of under five			
≤1	2229	47.10	(45.16–49.04)
2	2129	44.98	(43.34–46.75)
≥3	374	7.92	(6.82– 9.18)
Head of household			
Male	3564	75.31	(73.61–76.94)
Female	1168	24.69	(23.06–26.39)
Community characteristics			
Place of residence			
Urban	639	13.50	(11.04–16.42)
Rural	4093	86.50	(83.58–88.96)
Geographical region			
Northern	555	11.74	(10.10–13.60)
Central	2044	43.18	(40.22–46.20)
Southern	2133	45.08	(42.23–47.96)
Health Service utilization			
Vitamin A last 6 months			
No	1633	34.52	(32.67–36.41)
Yes	3099	65.48	(63.59–67.33)
Place of delivery			
Non-health facility	325	6.88	(5.85– 8.06)
Health facility	4407	93.12	(91.94–94.41)
Number of ANC visits			
Inadequate	2389	50.49	(48.46–52.51)
Adequate	2343	49.51	(47.48–51.54)

Post-natal (within 2 months)			
No	2631	55.60	(53.07–58.10)
Yes	2101	44.40	(41.90–46.93)
Outcomes			
Introduction of solid, semi-solid or soft foods (n=774)			
No	118	15.19	(12.22–18.70)
Yes	656	84.81	(81.30–87.77)
Minimum meal frequency			
No	3322	70.20	(68.40–71.93)
Yes	1410	29.80	(28.06–31.59)
Minimum dietary diversity			
No	3553	75.08	(73.03–77.02)
Yes	1179	24.92	(22.98–26.97)
Minimum acceptable diet			
No	4337	91.64	(90.54–92.63)
Yes	395	8.36	(7.37–9.46)

*Weighted frequency; ⁑ weighted percentage; CI = confidence interval; ANC= antenatal care

Table 2 Percentage of food intake among children aged 6-23 months according to food groups MDHS, 2015-2016 (n=4732)

Characteristics	Frequency	Percent	
	*n**	%⁑	95% (CI)
Grains, roots and tubers			
Not received	1455	30.75	(28.91–32.66)
Received	3277	69.25	(67.34–71.09)
Legumes and nuts			
Not received	3497	73.90	(71.79–75.89)
Received	1235	26.10	(24.10–28.21)
Dairy products			
Not received	4332	91.54	(90.25–92.67)
Received	400	8.46	(07.33–09.75)
Fresh			
Not received	3254	68.76	(66.92–70.55)
Received	1478	31.24	(29.45–33.08)
Eggs			
Not received	4168	88.07	(86.75–89.27)
Received	564	11.93	(10.73–13.24)
Vitamin-A rich fruits and vegetables			
Not received	2481	52.43	(49.98–54.87)
Received	2251	47.57	(45.13–50.02)
Other fruits and vegetables			
Not received	1522	32.15	(30.26–34.10)
Received	3211	67.85	(65.89–69.74)

*Weighted frequency; ⁑ weighted percentage; CI, confidence interval

Table 3 Distribution of study participants' characteristics according to childhood complementary feeding practices MDHS 2015-2016

Characteristic	Introduction to solid, semi-solid or soft foods			Minimum Meal Frequency			Minimum Dietary Diversity			Minimum Acceptable Diet		
	No	Yes	χ^2/P	No	Yes	χ^2/P	No	Yes	χ^2/P	No	Yes	χ^2/P
	n (%)	*n (%)*		*n (%)*	*n (%)*		*n (%)*	*n (%)*		*n (%)*	*n (%)*	
Sex of the child			0.660			0.920			0.243			0.116
Male	58 (49.4)	342 (52.1)		1687 (50.7)	713 (50.6)		1822 (51.3)	578 (49.0)		2219 (51.2)	181 (45.8)	
Female	59 (50.6)	315 (47.9)		1635 (49.2)	697 (49.4)		1731 (48.7)	602 (51.0)		2118 (48.8)	214 (54.2)	
Age of the child (months)						<0.001			<.0001			0.219
6-11	§			1043 (31.4)	604 (42.9)		1368 (38.5)	280 (23.7)		1521 (35.1)	127 (32.2)	
12-17				1153 (34.7)	448 (31.8)		1164 (32.8)	437 (37.0)		1476 (34.0)	125 (31.6)	
18-23				1126 (33.9)	358 (25.4)		1021 (28.7)	463 (39.3)		1340 (30.9)	143 (36.3)	
Perceived birth size			0.479			0.333			0.116			0.0.21
Very small	13 (11.7)	103 (15.6)		518 (15.6)	198 (14.0)		559 (15.7)	157 (13.3)		675 (15.6)	41 (10.3)	
Average	68 (57.6)	335 (51.1)		1657 (49.9)	738 (52.4)		1809 (50.9)	586 (49.7)		2170 (50.0)	225 (56.6)	
Very large	36 (30.7)	219 (33.3)		1147 (34.5)	474 (33.6)		1185 (33.4)	437 (37.0)		1492 (34.4)	130 (32.9)	
Maternal age (years)			0.897			0.063			0.022			0.346
15-24	58 (49.8)	330 (47.0)		1417 (42.6)	663 (47.0)		1590 (44.7)	490 (41.5)		1904 (43.9)	175 (44.2)	
25-34	44 (37.1)	251 (38.5)		1357 (40.9)	543 (38.5)		1376 (38.7)	525 (44.5)		1731 (39.9)	169 (42.8)	
35-49	15 (13.1)	76 (14.5)		548 (16.5)	204 (14.5)		587 (16.6)	165 (14.0)		701 (16.2)	52 (13.0)	
Maternal education levels			0.069			0.049			<.0001			<.0001
No formal education	21 (18.3)	71 (11.0)		400 (12.0)	154 (10.9)		485 (13.6)	70 (59.1)		530 (12.2)	24 (6.1)	
Primary	76 (64.4)	416 (63.3)		2263 (68.1)	918 (65.1)		2438 (68.6)	742 (62.9)		2937 (67.7)	244 (61.6)	
Secondary and above	20 (17.3)	170 (25.7)		659 (19.9)	338 (24.0)		630 (17.7)	368 (31.2)		870 (20.1)	128 (32.4)	
Maternal occupation			<.0001			0.606			<.0001			0.098
No employment	61 (52.0)	201 (30.6)		1009 (30.4)	430 (30.5)		1134 (31.9)	305 (25.8)		1317 (30.4)	122 (30.8)	
Agriculture	32 (27.1)	293 (44.7)		1467 (44.2)	644 (44.7)		1666 (46.9)	446 (37.8)		1957 (45.1)	155 (39.1)	
Non-agriculture	24 (20.9)	163 (24.7)		846 (25.5)	336 (28.3)		753 (21.2)	429 (36.4)		1063 (24.5)	207 (30.1)	
Religion			0.125			0.612			<.0001			0.048
Catholic	22 (19.2)	145 (22.0)		588 (17.7)	263 (18.7)		622 (17.5)	229 (19.4)		768 (17.7)	83 (21.0)	
Protestant	14 (12.0)	131 (20.0)		680 (20.5)	301 (44.7)		679 (19.1)	302 (25.6)		883 (20.3)	99 (24.9)	
Muslim and other	81 (68.8)	381 (58.0)		2054 (61.8)	846 (28.3)		2252 (63.4)	649 (55.0)		2687 (62.0)	2901 (54.1)	
Exposure to mass media			0.231			<0.001			<.0001			<.0001
No	84 (71.3)	423 (64.4)		2288 (68.9)	863 (61.2)		2518 (70.9)	633 (53.7)		2977 (68.6)	175 (44.2)	
Yes	33 (28.7)	234 (35.6)		1034 (31.1)	547 (38.8)		1035 (29.1)	547 (46.3)		1360 (31.4)	220 (55.8)	
Marital status			0.260			0.266			0.211			0.045
Unmarried	27 (23.1)	116 (17.7)		567 (17.1)	219 (15.5)		607 (17.1)	178 (15.1)		735 (16.9)	51 (12.8)	
Married	90 (76.9)	541 (82.3)		2755 (82.9)	1191 (84.5)		2946 (82.9)	1002 (84.9)		3602 (83.1)	345 (87.2)	
Ethnicity			0.241			0.768			0.002			0.427
Chewa	38 (32.3)	242 (36.9)		1188 (35.8)	474 (33.6)		1230 (34.6)	433 (36.7)		1534 (35.4)	128 (32.4)	
Tumbuka	10 (9.0)	47 (7.1)		281 (8.4)	124 (8.8)		309 (8.7)	96 (8.1)		367 (8.5)	38 (9.4)	
Lomwe	17 (14.7)	131 (19.9)		564 (17.0)	239 (16.9)		608 (17.1)	195 (16.6)		738 (17.0)	66 (16.6)	

Yao	30 (25.3)	97 (14.8)		530 (11.2)	238 (50.4)		632 (17.8)	136 (11.5)		715 (16.5)	53 (11.5)	
Ngoni	7 (6.2)	63 (9.6)		375 (11.3)	151 (10.7)		372 (10.5)	154 (13.0)		474 (10.9)	51 (13.4)	
Others	15 (15.2)	77 (11.7)		384 (11.6)	184 (13.0)		402 (11.3)	166 (14.1)		509 (11.8)	59 (14.9)	
Parity			0.569			0.213			<.0001			0.014
1	26 (22.5)	193 (29.4)		858 (25.8)	406 (28.8)		901 (25.4)	364 (30.8)		1136 (26.2)	128 (32.3)	
2	30 (25.8)	163 (24.9)		666 (20.1)	291 (20.6)		702 (19.8)	255 (21.6)		863 (19.9)	94 (23.8)	
3	19 (15.8)	83 (12.6)		538 (16.2)	228 (16.2)		561 (15.8)	205 (17.4)		710 (16.4)	56 (14.2)	
4+	42 (35.7)	218 (33.1)		1260 (37.9)	485 (34.4)		1389 (39.1)	356 (30.2)		1628 (37.5)	117 (29.7)	
Household wealth			0.764			0.057			<.0001			<.0001
Poorest	32 (27.2)	159 (24.3)		898 (27.0)	310 (22.0)		1021 (28.7)	187 (15.9)		1161 (26.8)	48 (25.5)	
Poorer	29 (24.6)	166 (25.2)		760 (22.9)	329 (23.3)		861 (24.2)	229 (19.4)		1005 (23.2)	84 (23.0)	
Middle	16 (13.9)	113 (17.3)		630 (19.0)	291 (20.6)		707 (19.9)	214 (18.2)		850 (19.6)	71 (19.5)	
Richer	23 (20.1)	100 (15.3)		548 (16.5)	238 (50.2)		568 (16.0)	218 (18.4)		706 (16.3)	80 (21.1)	
Richest	17 (14.2)	119 (17.9)		486 (14.6)	242 (51.3)		366 (11.2)	332 (28.2)		616 (14.2)	112 (24.4)	
Household size			0.733			0.501			0.029			0.188
<5	45 (38.5)	265 (40.4)		1267 (38.2)	557 (39.5)		1328 (37.4)	496 (42.1)		1656 (31.2)	168 (42.4)	
≥5	72 (61.5)	392 (59.6)		2055 (61.9)	853 (60.5)		2225 (62.6)	683 (57.9)		2681 (61.8)	228 (57.6)	
Sex of household			0.168			0.128			0.001			0.037
Male	79 (67.3)	492 (74.8)		2477 (74.7)	1087 (77.1)		2630 (70.0)	934 (79.2)		3245 (74.8)	319 (80.7)	
Female	38 (32.7)	165 (25.3)		845 (25.4)	323 (22.9)		922 (30.0)	246 (20.8)		1092 (25.2)	76 (19.3)	
Number of under-five in household			0.301			0.773			0.009			0.175
<1	48 (41.6)	256 (39.0)		1554 (46.8)	675 (47.8)		1613 (45.4)	616 (47.8)		2021 (46.6)	208 (52.5)	
2	52 (51.7)	338 (51.4)		1509 (45.4)	620 (44.0)		1654 (46.6)	475 (40.3)		1974 (45.5)	155 (39.2)	
3+	17 (14.1)	63 (9.6)		259 (7.8)	115 (8.2)		286 (8.0)	89 (7.9)		342 (7.9)	33 (8.3)	
Vitamin A in the last 6 months			0.838			0.423			0.001			0.571
No	54 (46.7)	317 (48.1)		1131 (34.0)	503 (35.7)		1283 (36.1)	351 (29.7)		1503 (34.7)	130 (33.0)	
Yes	63 (53.3)	340 (51.9)		2191 (66.0)	907 (64.4)		2270 (63.9)	829 (70.1)		2834 (65.3)	265 (67.0)	
Place of delivery			0.879			0.837			0.043			0.152
Non-health facility	6 (5.5)	39 (5.9)		226 (6.8)	99 (7.0)		265 (7.5)	61 (5.2)		306 (7.1)	19 (4.8)	
Health facility	111 (94.6)	618 (94.1)		3096 (93.2)	1311 (93.0)		3288 (92.6)	1119 (94.9)		4030 (92.9)	377 (95.2)	
Number of antenatal visits			0.851			0.488			0.103			0.604
Inadequate	61 (52.1)	334 (50.9)		1691 (50.9)	698 (49.5)		1824 (51.4)	565 (47.9)		2196 (50.6)	193 (48.9)	
Adequate	56 (47.9)	323 (49.1)		1631 (49.1)	712 (50.5)		1729 (48.6)	615 (52.1)		2141 (49.4)	202 (51.1)	
Postnatal check within 2 months			0.147			0.476			<.0001			0.019
No	75 (64.4)	363 (55.2)		1862 (56.0)	769 (54.6)		2054 (56.0)	577 (54.6)		2440 (56.3)	190 (48.2)	
Yes	42 (35.6)	294 (44.8)		1460 (44.0)	641 (45.5)		1499 (44.0)	603 (45.5)		1896 (43.7)	204 (51.8)	
Place of residence			0.032			0.474			<.0001			<.0001
Urban	9 (7.4)	110 (16.7)		437 (13.1)	202 (14.4)		365 (10.3)	274 (23.2)		551 (12.7)	88 (22.2)	
Rural	108 (92.6)	547 (83.3)		2885 (86.9)	1208 (85.6)		3188 (89.7)	906 (76.8)		3785 (87.3)	309 (77.8)	
Geographical region			0.007			0.290			<.0001			0.460
Northern	20 (17.6)	68 (10.3)		390 (11.7)	165 (11.7)		425 (12.0)	130 (11.0)		504 (11.6)	51 (13.0)	
Central	32 (27.3)	302 (45.9)		1464 (44.1)	580 (41.1)		1452 (40.9)	592 (50.2)		1864 (43.0)	179 (45.4)	
Southern	65 (55.1)	287 (43.8)		1468 (44.2)	665 (47.2)		1676 (47.1)	458 (38.8)		1969 (45.4)	165 (41.6)	

Note: All n and % were weighted; χ^2/P, Pearson's Chi-square p-value; §, sample for introduction of solid, semi-solid or soft foods (6 – 8 months)

Table 4 Factors associated with childhood complementary feeding practices MDHS, 2015-2016

	Introduction to solid, semi-solid or soft foods		Minimum meal frequency		Minimum dietary diversity		Minimum acceptable diet	
	AOR 95% (CI)	p-value	AOR 95% (CI)	p-value	AOR 95% (CI)	p-value	AOR 95% (CI)	p-value
Sex of the child								
Male	—		—		1.00		1.00	
Female	—		—		1.01 (0.85–1.19)	0.937	1.19 (0.91–1.56)	0.200
Age of the child (months)								
6-11	—		1.00		1.00		1.00	
12-17	—		**0.67 (0.55–0.80)**	**<0.001**	**1.90 (1.54–2.40)**	**<0.001**	0.99 (0.71–1.40)	0.995
18-23	—		**0.56 (0.46–0.68)**	**<0.001**	**2.30 (1.82–2.91)**	**<0.001**	1.36 (0.99–1.87)	0.061
Perceived birth size								
Very small	—		—		1.00		1.00	
Average	—		—		1.10 (0.83–1.44)	0.508	**1.64 (1.11–2.42)**	**0.013**
Very large	—		—		1.20 (0.90–1.60)	0.213	1.33 (0.90–2.00)	0.155
Maternal age (years)								
15-24	—		1.00		1.00			
25-34	—		0.81 (0.64–1.02)	0.079	**1.53 (1.17–1.20)**	**0.002**	—	
35-49	—		0.81 (0.58–1.13)	0.224	**1.56 (1.08–2.25)**	**0.017**	—	
Maternal education levels								
No formal education	1.00		1.00		1.00		1.00	
Primary	1.62 (0.87–3.00)	0.125	0.95 (0.74–1.23)	0.719	**1.65 (1.20–2.27)**	**0.002**	1.30 (0.77–2.19)	0.318
Secondary and above	**2.46 (1.12–5.39)**	**0.025**	1.14 (0.84–1.56)	0.404	**1.67 (1.14–2.45)**	**0.008**	1.40 (0.76–2.57)	0.283
Maternal occupation								
No employment	1.00		—		1.00		1.00	
Agriculture	**2.65 (1.59–4.43)**	**<0.001**	—		1.16 (0.93–1.45)	0.187	1.04 (0.75–1.44)	0.821
Non-agriculture	1.45 (0.86–2.46)	0.165	—		**1.78 (1.39–2.26)**	**<0.001**	1.08 (0.76–1.54)	0.651
Religion								
Catholic	1.00		—		1.00		1.00	
Protestant	1.38 (0.68–2.78)	0.372	—		1.12 (0.85–1.47)	0.437	0.92 (0.63–1.34)	0.652
Muslim and other	0.99 (0.58–1.68)	0.972	—		0.99 (0.79–1.24)	0.915	0.82 (0.59–1.14)	0.239

Exposure to mass media								
No	1.00		1.00		1.00		1.00	
Yes	1.28 (0.79–2.05)	0.317	**1.31 (1.11–1.56)**	**0.002**	**1.37 (1.14–1.65)**	**0.001**	**2.08 (1.61–2.69)**	**<0.001**
Marital status								
Unmarried	—		—		1.00		1.00	
Married	—		—		0.92 (0.69–1.21)	0.529	1.19 (0.81–1.75)	0.375
Ethnicity								
Chewa	1.00				1.00			
Tumbuka	1.53 (0.55–4.28)	0.415	—		0.91 (0.60–1.37)	0.642	—	
Lomwe	1.49 (0.68–3.25)	0.321	—		1.10 (0.77–1.56)	0.607	—	
Yao	1.13 (0.54–2.37)	0.754	—		0.78 (0.55–1.12)	0.175	—	
Ngoni	1.18 (0.51–2.72)	0.693	—		1.10 (0.81–1.49)	0.538	—	
Others	1.66 (0.75–3.70)	0.211	—		1.78 (0.84–1.64)	0.336	—	
Parity		NS						
1	—		1.00		1.00		1.00	
2	—		0.99 (0.76–1.26)	0.934	0.80 (0.61–1.05)	0.105	1.01 (0.67–1.52)	0.954
3	—		1.10 (0.82–1.47)	0.520	**0.67 (0.47–0.94)**	**0.021**	0.74 (0.48–1.12)	0.158
4+	—		1.07 (0.77–1.47)	0.691	**0.52 (0.36–0.75)**	**<0.001**	0.76 (0.50–1.14)	0.179
Household wealth								
Poorest	—		1.00		1.00		1.00	
Poorer	—		1.13 (0.89–1.43)	0.311	1.28 (0.97–1.69)	0.081	**1.65 (1.05–2.58)**	**0.030**
Middle	—		1.25 (0.97–1.61)	0.080	**1.36 (1.03–1.80)**	**0.031**	**1.59 (1.05–2.40)**	**0.029**
Richer	—		1.06 (0.82–1.38)	0.647	**1.68 (1.23–2.29)**	**0.001**	**1.89 (1.20–2.97)**	**0.006**
Richest	—		1.15 (0.85–1.56)	0.357	**2.64 (1.81–3.87)**	**<0.001**	**2.27 (1.37–3.78)**	**0.002**
Household size								
<5	—		—		1.00		1.00	
≥5	—		—		0.86 (0.68–1.10)	0.224	0.97 (0.69–1.38)	0.884
Sex of head of household								
Male	1.00		1.00		1.00		1.00	
Female	0.80 (0.50 –1.28)	0.356	0.91 (0.76–1.09)	0.288	0.82 (0.66–1.02)	0.079	0.93 (0.65–1.34)	0.652
Number of under-five in HH								

<1	—		—		1.00		1.00	
2	—		—		1.02 (0.83–1.26)	0.846	0.95 (0.69–1.31)	0.750
3+	—		—		1.29 (0.91–1.84)	0.157	1.20 (0.71–2.03)	0.494
Vitamin A in the last 6 months								
No	—		—		1.00		—	
Yes	—		—		**1.23 (1.03–1.48)**	**0.024**	—	
Place of delivery								
Non-health facility	—		—		1.00		1.00	
Health facility	—		—		1.16 (0.80–1.66)	0.434	1.04 (0.61–1.78)	0.887
Number of antenatal visits								
Inadequate	—		—		1.00		—	
Adequate	—		—		1.01 (0.85–1.19)	0.944	—	
Postnatal check within 2 months								
No	1.00		—		1.00		1.00	
Yes	1.07 (0.68 –1.68)	0.777	—		**1.24 (1.01–1.51)**	**0.040**	1.21 (0.93–1.59)	0.154
Place of residence								
Urban	1.00		—		1.00		1.00	
Rural	0.77 (0.40–1.45)	0.414	—		0.94 (0.68–1.31)	0.722	1.01 (0.65–1.55)	0.979
Geographical region								
Northern	1.00		—		1.00		—	
Central	**2.84 (1.17–6.90)**	**0.021**	—		**1.59 (1.09–2.32)**	**0.017**	—	
Southern	1.70 ((0.79–3.65)	0.176	—		1.12 (0.78–1.60)	0.531	—	

AOR= Adjusted Odds Ratio; CI = confidence interval; SE=Standard error; ANC= antenatal care