

Risk factors for severe acute malnutrition among children aged 6-59 months enrolled in CMAM Program Al-Sabeen Hospital, Sana'a City _Yemen

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Abstract

Background

SAM is one of the leading causes of morbidity and mortality in Yemen. The reasons behind persistently high prevalence of SAM in Yemen are still poorly understood.

Aims

To assess Risk factors for severe acute malnutrition among children aged 6–59 months enrolled in CMAM Program Al-Sabeen Hospital, Sana'a City _Yemen.

Methodology:

Unmatched case-control study was conducted on 194 (65 cases and 129 controls) children aged 6–59 months with their parents enrolled in CMAM program in Al-Sabeen hospital, Sana'a. The sample for this study was selected using convenience sampling method. Data were collected by using questionnaire as a face-to-face interview. The data collection tool was consisted of the potential risk factors (Children demographic, health care services, comorbidities, dietary, parent's socio-demographic, household environment and food security factors). Controls were matched to their cases on sex and on age. Data were analyzed using IBM SPSS. Binary regression was used to analyses the association of independent variables with SAM with a significance level of $p < 0.05$.

Results

At the comorbidities risk factors, SAM was significantly associated with diarrhoea (AOR = 3.8, 95% CI = 1.976–7.666; $p < 0.05$), anorexia (AOR = 10.5, 95% CI = 3.987–27.590; $p < 0.05$), intractable vomiting (AOR = 6.3, 95% CI = 2.829–13.936; $p < 0.05$), gastroenteritis (AOR = 3.4, 95% CI = 1.533–7.776; $p < 0.05$), ARI (AOR = 4.5, 95% CI = 1.810–11.376; $p < 0.05$) and anemia (AOR = 5.6, 95% CI = 1.885–16.730; $p < 0.05$). For dietary factors, SAM was associated with exclusive breastfeeding (AOR = 2.4, 95% CI = 1.287–4.400; $p < 0.05$), duration of exclusive breastfeeding (AOR = 2.8, 95% CI = 1.246–6.588; $p < 0.05$), types of foods included in the child's diet on a typical day (AOR = 2.9, 95% CI = 1.459–6.012; $p < 0.05$), legumes/pulses (AOR = 2.2, 95% CI = 1.108–4.287; $p < 0.05$), dairy products (AOR = 3.2, (95% CI = 1.696–6.039; $p < 0.05$). For household environment and food security factors, household food availability (AOR = 4.3, 95% CI = 1.269–15.163; $p < 0.05$), latrine availability (AOR = 5.3, 95% CI = .998–28.063; $p < 0.05$), caretaker's hand washing before preparing food (AOR = 4.2, 95% CI = 1.469–11.873; $p < 0.05$), caretaker's hand washing before eating (AOR = 5.0, 95% CI = 1.484–16.998; $p < 0.05$), and caretaker hand washing after managing child feces (AOR = 6.7, 95% CI = 1.760–25.882; $p < 0.05$). For healthcare services factors, vaccination (OR < 1 which means the children who received vaccination were protective against SAM)

and regular access to healthcare services (AOR = 7.8, 95% CI = 2.434–25.081; $P < 0.05$). For demographic factors among children, age 12–23 months (AOR = 2.8, 95% CI = 1.044–7.509; $P < 0.05$) and 24–59 months (AOR = 4.1, 95% CI = 1.020–4.792; $P < 0.05$), place of residence (AOR = 5.1, 95% CI: 02.436–10.536; $P < 0.001$), birth weight (AOR = 3.7, 95% CI = 1.909–7.220; $p < 0.001$). For socio-demographic factors of parents, father occupation (AOR = 2.9, 95% CI: 1.561–5.758; $P < 0.001$) and family income (AOR = 2.0, 95% CI: 1.561–5.758; $P < 0.05$).

Conclusion

The present study identified the need to concern both treatment and prevention of infections in children through an integrated approach. Well-organized efforts to improve child feeding practices, household hygiene and sanitation conditions, along with increasing household food diversity are likely to lead to improved nutritional status of children aged 6–59 months.

Introduction

Malnutrition, as defined by the World Health Organization (WHO), is a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients, and is clinically manifested or detected only by biochemical, anthropometric, or physiological tests (**WHO, 2022**). Malnutrition is a major global health problem primarily affecting under-five children and is a major public health challenge faced by many developing countries (Govender, Rangiah, Kaswa, & Nzaumvila, 2021) Malnutrition in children is of high concern in developing countries such as Yemen (**UNICEF, 2020**). The two main kinds of Acute Malnutrition (AMN) in children are Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM). SAM is defined by a low Mid-Upper Arm Circumference (MUAC) ≤ 11.5 cm, weight-for-height below -3 Z-scores of the median WHO growth standards, and/or the presence of bilateral pitting edema (Lenters, Wazny, & Bhutta, 2016). When a child is found to be severely underweight for their height when compared to the WHO reference population, muscle wasting is identified using the MUAC and/or bilateral pitting edema or a very low MUAC (Grellety & Golden, 2018) SAM results from insufficient energy (kilocalories), fat, protein, and/or other nutrients (vitamins, minerals, etc.) to meet individual needs (MSF, 2025).

Aims

To assess Risk factors for severe acute malnutrition among children aged 6–59 months enrolled in CMAM Program Al-Sabeen Hospital, Sana'a City _Yemen.

Methods and materials

Study design and setting

A case-control study was conducted to assess the risk factors of SAM among children aged 6–59 months enrolled in the CMAM program in Al-Sabeen hospital Sana'a city, Yemen. The study was conducted on cases who had been admitted and referred at any time from 01 June 2024 to 1 January 2025 (incident and prevalent). Cases were all children aged 6–59 months admitted to CMAM program in Al-Sabeen hospital, Sana'a city with a diagnosis of SAM and still received inpatient or outpatient care. Controls were all children aged 6–59 months of the same age and gender and attending the same child welfare clinic as the case and with good nutritional status.

Study participants and selection procedure

In a case-control study, the researcher begins with an outcome then go back to investigate the risk factors. This is achieved through identification of a population who have developed the outcome of interest and identifying the population that does not have the outcome of interest. Once cases and controls have been identified, the researcher was go back in time to know which subject in each group had the exposure(s) and comparing the proportions of the exposure between the two groups (Leon Gordis, 2014). The following steps of case-control design were administered:

1. **Selection of cases** (children with SAM): cases were all children aged 6–59 months with SAM, old, newly admitted, relapsed or readmitted to the CMAM program in Al-Sabeen hospital, Sana'a city from 01 June 2024 to 1 January 2025. Anthropometric criteria for SAM were as follows: weight-for-height z-score of < -3 standard deviations (SD) of the WHO standards and/or bilateral pitting oedema and/or MUAC < 115 mm and/or bilateral pitting oedema.
2. **Selection of controls** (children without SAM): The controls were including all children aged 6–59 months without SAM from same source of case with a (MUAC ≥ 125 mm and WHZ of ≥ -1.5 SD and without bilateral pitting edema), in good general health and without known past episodes of SAM.

Data collection technique and Tool

Data collection technique: the researcher was used two methods for data collection namely i) review of records which is the process of analyzing medical records based on a set of criteria, and ii) face-to-face interview with a caregiver of eligible children.

Data collection tool: A structured questionnaire was administered to collect data. The variables used in the development of the questionnaire was mostly from the review of the literature of the previous studies on child malnutrition and based on UNICEF conceptual framework of causes of malnutrition (**Al-Mushiki et al., 2023**).

Those variables are the risk factors that have been investigated by other researchers in other settings. Legibility and completeness of data was ensured during the data collection period and any inconsistencies was addressed during the fieldwork. The questionnaire was initially prepared in English, then translated into Arabic, and then translated back into English to check equivalence. The data

collection tool was made up of closed-ended questions and consisted of the following potential risk factors:

1. **Children demographic characteristics factors:** age, sex, place of residence, birth order, birth weight (defined by birth weight < 2500 grams or < 2500 grams).
2. **Health care services risk factors:** ask if the child received BCG, polio vaccine, pentavalent, pneumococcal, rotavirus, measles vaccines and vitamin A supplement. Vaccination up to date (complete/incomplete) and regular access to healthcare services(yes/no).
3. **Comorbidities risk factors:** recurrent/chronic diarrhea (Recurrent/chronic diarrhea is defined as three soft or liquid stools for at least 24 hours, two or more weeks prior to the deterioration of the nutritional status of the child), anorexia, intractable vomiting, gastroenteritis, ARI, anemia, malaria, measles, Human Immuno-Deficiency Virus/Acquired Immuno-Deficiency Syndrome (HIV/AIDS), TB, cancer and other.
4. **Dietary risk factors:** Ask mothers if given exclusive breastfeeding after birth, age of introduction of complementary feeding (considered precocious when this introduction was made before 6 months), age of breastfeeding's cessation (considered precocious when this stop was done before 6 months), and number of daily meals, age of child weaning.

The assessment of age of introduction of complementary diets was made by asking the mother if at what age the child had received solid, semisolid, or soft foods. Duration of breastfeeding, age of breastfeeding's cessation was assessed by asking the mother at what age the child stopped breastfeeding. Types of foods included in the child's diet on a typical day and the evaluation of the minimum number of daily meals was done by asking the mother the minimum number of times the child had received solid, semisolid, or soft foods per day.

5. Mother's socio-demographic characteristics factors: maternal age at birth, parity, occupational status, and level of education.

6. Father's socio-demographic characteristics factors: occupation, level of education and family monthly income

7. Household environment and food security risk factors: family history of malnutrition, number of children under 5 in the family and family size (defined by the number of people in the family and living under the same roof). Household food availability satisfactory (Yes/No), latrine availability (Yes/No), source of drinking water protected (Yes/No), caretaker's hand washing habits (before preparing food, before eating, before breastfeeding or feeding a child, after defecation, after managing child's faeces) (Yes/No).

Data analysis

Descriptive statistics were used to summarize socio-demographic characteristics, dietary intake, and household environmental factors among cases and controls. Categorical variables were presented as frequencies and percentages. Bivariate binary logistic regression was conducted to assess associations

between potential risk factors and severe acute malnutrition (SAM). Adjusted Odds Ratios (AOR) with 95% Confidence Intervals (CI) were calculated. Multicollinearity was assessed using the Variance Inflation Factor (VIF), with no variables exceeding a VIF of 4. Statistical significance was set at $p < 0.05$.

Ethical Considerations

Ethical approval

was obtained from Al-Razi University and Al-Sabeen hospital. Verbal informed consent was obtained from all caregiver prior to data collection.

Result

Demographic characteristics among cases and controls groups

This study included a total of 194 children aged 6 to 59 months, comprising 65 cases with severe acute malnutrition (SAM) and 129 controls. The mean age of the cases was 29 months (± 18 SD), while that of the controls was 32 months (± 17 SD). Children aged 24–59 months represented the largest age group in both cases (19.6%) and controls (43.3%). In terms of sex distribution, 18% of the cases and 38.7% of the controls were females. The male-to-female ratio was approximately 1.2:1 in the case group and 1.4:1 in the control group. Regarding birth order, nearly one-quarter (24.2%) of the cases and almost half (47.9%) of the controls were of birth order less than three. With respect to place of residence, 20.1% of the cases resided in urban areas compared to 58.8% of the controls, suggesting a higher prevalence of SAM in rural settings. Concerning birth weight, 18.6% of the cases and 54.6% of the controls were born with a weight of ≥ 2500 grams. Vaccination coverage showed that only 19.1% of the cases had completed their immunization schedule, whereas 45.9% of the controls had complete vaccinations. Furthermore, regular access to healthcare services was reported among 26.8% of the cases and 64.4% of th

e controls, indicating a potential li

nk between healthcare accessibility and nutritional status (**show** Table 1).

Comorbidities among children aged 6–59 months

This study examined the prevalence of comorbidities among children aged 6–59 months in both case (SAM) and control (No SAM) groups. The analysis revealed notable differences between the two groups regarding associated health conditions. Among the SAM group, the most frequently reported comorbidity was recurrent diarrhea, affecting 28 children (14.4%), followed by intractable vomiting in 24 children (12.4%). In contrast, 21 children (10.8%) in the control group reported recurrent diarrhea, and 11 children (5.7%) experienced intractable vomiting.

Other conditions such as gastroenteritis and ARIs were also more prevalent in the SAM group (11.3% and 25.8%, respectively) compared to the control group (6.2% and 4.1%, respectively). Anorexia was reported in 22.2% of SAM cases, with 11.3% experiencing it as a comorbidity, whereas only 3.1% of the control group had anorexia. prevalence of anemia in the SAM group was 6.2%, which is higher than the 1.5% reported in the control group. Malaria, measles, and HIV/AIDS were rare among both groups, with slightly higher frequencies in SAM cases. Tuberculosis (TB) and cancer were reported in 0.5% of SAM children but not observed in the control group. Diabetes mellitus (DM) was reported in one child in either group (show Table 2).

Household environment and food security among children aged 6–59

Months

Household environment and food security among cases and controls groups

As regards household environment and food security factors among cases and controls groups, the finding of the study showed that in cases group, fewer than a third (23.7%) of the caretakers without family history of malnutrition, 5.7% of the caretakers were not hand washing before preparing food, 5.2% were not used protected sources of drinking water and (4.6%) of the caretakers were not hand washing before breastfeeding or feeding a child.

In controls group, more than half (52.1%) of the caretakers had no family history of malnutrition, 63.4% of the caretakers were not hand washing before preparing food, nearly two thirds (61.9%) were not used protected sources of drinking water and 57.7% of the caretakers were not hand washing before breastfeeding or feeding a child. More details presenting in (Table 3).

Dietary factors among children aged 6–59 months

Exclusive breastfeeding after birth among cases and controls groups

In cases group 32 (16.5%) were given exclusive breastfeeding, 33 (17.0%) were not given breastfeeding. Among controls 90(46.4%) were given exclusive breastfeeding, 39 (20.1%) were not given breastfeeding (Fig. 1).

Types of foods included in the child's diet among cases and controls groups

Fifty (25.8%) of children with SAM were not ate legumes on a typical day compared to 78(40.2%) of children without SAM followed by 43(22.2%) of children with SAM were not ate meat/fish/eggs on a

typical day compared to 70 (36.1%) of children without SAM. More details presenting in (Table 4).

Duration of exclusive breastfeeding among cases and controls groups

Twelve of cases' mothers (9.6%) and 35 (28%) of controls' mothers had exclusively breastfed their children < 6 months of age. 21.6% of cases' mothers, whereas 40.8% of controls' mothers had exclusively breastfed their children for ≥ 6 months of age. (Fig. 2).

Age at the start complementary feeding among cases and controls groups

The majority of the cases (18.9%) and controls 39.7% had initiated complementary feeding at < 6 months of age. While 14.9% of the cases, and 26.8% of controls had initiated complementary feeding at ≥ 6 months of age. (Fig. 3).

Age at the child weaning among cases and controls groups

Accordingly, 52 (14.9%) of cases and 124 (25.8%) of controls had initiated weaning at < 12 months while 51 (18.6%) of cases and 147 (40.7%) of controls had initiated weaning at ≥ 12 months. (Fig. 4).

Frequency of feeding meals per day among cases and controls groups

As regards to frequency of feeding meals per day among cases and controls groups the findings of the study showed that in cases group, 11 (5.7%) had less than 3 meals per day and 54 (27.8%) had 3 and more meals per day compared to controls group, 11 (5.7%) had less than 3 meals per day and 118 (60.8%) had 3 and more meals per day. (Fig. 5).

Risk factors associated with SAM among cases and controls groups

Immediate causes of malnutrition among cases and controls groups

Comorbidities risk factors associated with SAM

Table 5 shows AOR for comorbidities risk factors associated with SAM among cases and controls, the findings of the study showed that:

Morbidity status of the child with diarrhea is significantly associated with SAM of the children. Cases had more history of diarrhea than the controls, 28 (43.1%) compared to 21 (16.3%) respectively. The results of binary regression showed that the risk of SAM was independently associated with diarrhea (AOR = 3.892, 95% CI = 1.976–7.666; $p < 0.05$).

Morbidity status of the child with anorexia is significantly associated with SAM of the children. Cases had more history of anorexia than the controls, 22(33.8%) compared to 6(4.7%) respectively. The results of binary logistic regression showed that the risk of SAM was independently associated with anorexia (AOR = 10.488, 95% CI = 3.987–27.590; $p < 0.05$).

Morbidity status of the child with intractable vomiting is significantly associated with SAM of the children. Cases had more history of intractable vomiting than the controls, 24(36.9%) compared to 11(8.5%) respectively. The results of binary regression showed that the risk of SAM was independently associated with intractable vomiting (AOR = 6.279, 95% CI = 2.829–13.936; $p < 0.05$).

Morbidity status of the child with gastroenteritis is significantly associated with SAM of the children. Cases had more history of gastroenteritis than the controls, 17(26.2%) compared to 12(9.3%) respectively. The results of binary regression showed that the risk of SAM was independently associated with gastroenteritis (AOR = 3.453, 95% CI = 1.533–7.776; $p < 0.05$).

Morbidity status of the child with ARI is significantly associated with SAM of the children. Cases had more history of ARI than the controls, 15(23.1%) compared to 8(6.2%) respectively. The results of binary regression showed that the risk of SAM was independently associated with ARI (AOR = 4.537, 95% CI = 1.810-11.376; $p < 0.05$).

Morbidity status of the child with anemia is significantly associated with SAM of the children. Cases had more history of anemia than the controls, 12(18.5%) compared to 5(3.9%) respectively. The results of binary regression showed that the risk of SAM was independently associated with anemia (AOR = 5.615, 95% CI = 1.885–16.730; $p < 0.05$).

Morbidity status of the child with malaria is not associated with SAM of the children. Cases and controls had same history of malaria, 2(3.1%) compared to 2(1.6%) respectively. The results of binary regression showed that the risk of SAM was not independently associated with malaria (AOR = .488, 95% CI = .496 – .068; $p > 0.05$). (**show** Table 5)

Dietary risk factors associated with SAM

Table 6 **shows** AOR for dietary factors associated with SAM among cases and controls. The results of binary regression showed that the risk of SAM was independently associated with exclusive breastfeeding (AOR = 2.380, 95% CI = 1.287- 4.400; $p < 0.05$). The odds of SAM were 2.3 times higher among children who did not receive exclusive breastfeeding after birth than who did received.

In this study, 87.7% of cases were duration of exclusive breastfeeding for < 6 months. whereas 71.3% of controls were duration of exclusive breastfeeding for < 6 months. The results of binary regression showed that the risk of SAM was independently associated with duration of exclusive breastfeeding (AOR = 2.865, 95% CI = 1.246–6.588; $p < 0.05$). The odds of SAM were 2.8 times higher among cases compared to controls.

As regard to types of foods included in the child's diet on a typical day and SAM, the proportion of children who did not eaten vegetables among cases was 22(33.8%) and the proportion among controls was 78(60.5%). The estimated AOR was 2.962 (95% CI:1.459–6.012). OR > 1 which means the risk among cases was 2.9 time more likelihood to having SAM than controls, there was association between SAM and eaten vegetables (p-value < 0.05).

As regard to legumes/pulses and SAM, the proportion of children did not eaten legumes/pulses in cases was 50(76.9%) and the proportion among controls was 78(60.5%). The estimated AOR was 2.179 (95% CI: 1.108–4.287). OR > 1 which means the risk among cases was 2.2 time more likelihood to having SAM than controls, there was association between SAM and eaten legumes/pulses (p-value < 0.05).

As regard to dairy products and SAM, the proportion of children who did not eat dairy products in cases group was 32(49.2%) and the proportion among controls group was 30(23.3%). The estimated AOR was 3.20 (95% CI: 1.696–6.039). OR > 1 which means the risk among cases was 3.2 time more likelihood to having SAM than controls, there was association between SAM and eaten dairy products (p-value < 0.001).

All others predictors were not associated with SAM (p > 0.05).

Underlying causes of malnutrition among cases and controls groups

Household environment and food security factors associated with SAM

Table 7 **shows** AOR for risk factors associated with SAM among cases and controls, the findings of household environment and food security factors and SAM showed:

The proportion of risk factors (family history of malnutrition) among children with SAM was 19(29.2%) and the proportion of risk factors among children without SAM was 28(21.7%). the occurrence of SAM and family history of malnutrition was not significantly associated with an increased likelihood of having SAM (p-value > 0.05, AOR= .671; 95% CI: .340 -1.323).

Increased households with children under 5 was not significantly associated with an increased likelihood of having SAM (p-value > 0.05). The estimated AOR was 1.216 (95% CI: .558 – 2.650). OR > 1 which means the odds of SAM children were 1.2 times higher compared to households without SAM.

Family size was not significantly associated with an increased likelihood of having SAM (p-value > 0.05). The estimated AOR was 1.006 (95% CI: .915-1.106). OR > 1 which means the odds of SAM children were 1 time higher compared to households without SAM.

The proportion of risk factors (household food availability) among children with SAM was 8(12.3%) and the proportion of risk factors among children without SAM was 4(3.1%). The estimated AOR was 4.386 (95% CI: 1.269–15.163). OR > 1 which means the household food availability among cases was 4.4 time more likelihood to having SAM than controls. There was association between SAM and household food availability (p -value < 0.05).

As regard to latrine availability and SAM, the proportion of risk factors (Latrine availability) among children with SAM was 5(7.7%) and the proportion of risk factors among children without SAM was 2(3.6%). The estimated AOR was 5.292 (95% CI: .998-28.063). OR > 1 which means the latrine availability among cases was 5.3 time more likelihood to having SAM than controls. There was association between SAM and latrine availability (p -value < 0.05).

As regard to source of drinking water protected and SAM, the proportion of risk factors (source of drinking water protected) among children with SAM was 10(15.4%) and the proportion of risk factors among children without SAM was 9(7.0%). The estimated AOR was 2.424 (95% CI: .932-6.302). OR > 1 which means the source of drinking water among cases was 2.4 time more likelihood to having SAM than controls, but there was no association between SAM and source of drinking water (p -value > 0.05).

As regard to caretaker's hand washing before preparing food and SAM, the proportion of risk factors (caretaker's hand washing before preparing food) among children with SAM was 11(16.9%) and the proportion of risk factors among children without SAM was 6(4.7%). The estimated AOR was 4.176 (95% CI: 1.469–11.873). OR > 1 which means the caretaker's hand washing before preparing food among cases was 4.2 time more likelihood to having SAM than controls. There was association between SAM and caretaker's hand washing before preparing food (p -value < 0.05).

As regard to caretaker's hand washing before eating and SAM, the proportion of risk factors (caretaker's hand washing before eating) among children with SAM was 9(13.8%) and the proportion of risk factors among children without SAM was 4(3.1%). The estimated AOR was 5.022 (95% CI: 1.484–16.998). OR > 1 which means the caretaker's hand washing before eating among cases was 5 time more likelihood to having SAM than controls. There was association between SAM and caretaker's hand washing before eating (p -value < 0.05).

As regard to caretaker's hand washing before breastfeeding or feeding a child and SAM, the proportion of risk factors (caretaker's hand washing before breastfeeding or feeding a child) among children with SAM was 9(13.8%) and the proportion of risk factors among children without SAM was 17(13.2%). The estimated AOR was 1.059 (95% CI: .444 -2.526). OR > 1 which means the caretaker's hand washing before breastfeeding or feeding a child among cases was 1 time more likelihood to having SAM than controls, but there was no association between SAM and caretaker's hand washing before breastfeeding or feeding a child (p -value > 0.05).

As regard to caretaker hand washing after managing child feces and SAM, the proportion of risk factors (caretaker hand washing after managing child feces) among children with SAM was 9(13.8%) and the

proportion of risk factors among children without SAM was 3(2.3%). The estimated AOR was 6.750 (95% CI: 1.760-25.882). OR > 1 which means the caretaker hand washing after managing child feces among cases was 6.7 time more likelihood to having SAM than controls. There was association between SAM and caretaker hand washing after managing child feces (p -value < 0.05).

Healthcare services risk factors associated with SAM

Table 8 **shows** AOR for risk factors (healthcare services) associated with SAM among cases and controls, the findings of binary logistic regression and estimated risk showed that, the AORs and 95% CI were .264 (95% CI: .103-.676), .311 (95% CI: .133-.724), .255 (95% CI: .255-.119), .308 (95% CI: .157-.606), .366 (95% CI: .192-.698), .264 (95% CI: .103-.676), .506 (95% CI: .273-.936) and .506 (95% CI: .273-.936) for BCG, polio, pentavalent, pneumococcal, rotavirus, measles vaccines and vitamin A supplement respectively.

In all predictors, the OR < 1 which means the children who received vaccination were protective against SAM. Increasing the proportion of children who received vaccination and vitamin A was associated with a reduction in the likelihood of exhibiting SAM (p -value < 0.05).

Vaccination up to date showed that children whose does not completed vaccination when compared to children whose completed vaccination had increased odds of SAM (AOR = 1.684, 95% CI: .909-3.119; P -value > 0.05).

Children whose respondents does not regular access to healthcare services when compared to children whose respondent's regular access to healthcare services had increased odds of SAM (AOR = 7.813, 95% CI: 2.434–25.081; P -value < 0.001).

Basic causes of malnutrition among cases and controls group

Demographic factors among children associated with SAM

In the bivariate analysis, increasing age was associated with an increased likelihood of having SAM. Compared to 6–11 months old children, increased odds of SAM were found among children 12–23 months (AOR = 2.800, 95% CI: 1.044–7.509; P < 0.05) and 24–59 months (AOR = 4.07, 95% CI: 1.020–4.792; P < 0.05). Females were 1.19 times more likely to exhibit SAM than males, but not significantly associated, AOR = 1.190, 95% CI: .653-2.169; P > 0.05).

Children whose respondents lived in rural settings when compared to urban ones had increased odds of SAM (AOR = 5.067, 95% CI: 02.436–10.536; P < 0.001). Birth weight showed that, 44.6% of the cases had birth weight < 2500 grams. whereas 17.8% of the controls had birth weight < 2500 grams. The results of binary regression showed that the risk of SAM was independently associated with low birth weight (AOR = 3.713, 95% CI = 1.909–7.220; p < 0.001). The odds of SAM were 3.7 times higher among cases compared to controls. Birth order factors were not significantly associated with SAM (p > 0.05). (Table 9).

Socio-demographic factors of parents associated with SAM of children

In the bivariate analysis, only children whose fathers unemployed when compared to employed ones had increased odds of SAM (AOR = 2.998, 95% CI: 1.561–5.758; $P < 0.001$). children whose mothers have number of delivery ≥ 4 when compared to children whose mothers have number of delivery < 4 were 1.1 times more likelihood to exhibit SAM, but not statistically associated (AOR = 1.093, 95% CI: .557-2.144; $P > 0.05$). The proportion of risk factor (family monthly income) among cases was 73.8% compared to 58.1% in controls group. The risk of SAM was independently associated with household who hadn't enough family monthly income (AOR = 2.033, 95% CI: 1.561–5.758; $P = 0.034$). All other socio-demographic factors of parents were not significantly associated with SAM ($P > 0.05$). (Table 10).

Discussion

this case control study conducted at Al-Sabeen hospital in Sana'a Yemen identified multiple risk factors of severe acute malnutrition (SAM) among children aged 6–59 months. The result found SAM is occur by diarrhea, inadequate feeding practices, poor Environmental conditions, incomplete immunization, and socioeconomic vulnerability. These results are consistent with the UNICEF conceptual framework.

Comorbidities and their relationship to severe acute malnutrition

A case-control study conducted at Al-Sabeen Hospital in Sana'a, Yemen, confirmed a strong association between recurrent diarrhea and severe acute malnutrition in children aged 6–59 months. In the severe acute malnutrition group, 43.1% had a history of recurrent diarrhea, compared to only 16.3% in the control group. Statistical analysis revealed a strong association ($p < 0.000$), with an adjusted odds ratio of 3.89. These results indicate that children with recurrent diarrhea are four times more likely to develop severe acute malnutrition. Studies conducted in Ethiopia by Ayana et al. (2015), Nibeyo Derej (2014), and Talbert et al. (2012), and in India by Guerrant, Oriá, Moore, Oriá, & Lima, (2008), have also found that children with diarrhea are more likely to be malnourished than those without. The current research has identified loss of appetite as a strong predictor of severe acute malnutrition (SAM) in children aged 6–59 months. Data showed that 33.8% of children diagnosed with SAM experienced loss of appetite, compared to only 4.7% in the control group (those without SAM). The relationship was highly statistically significant ($p < 0.000$), with an adjusted odds ratio (AOR) of 10.49, indicating that children with loss of appetite were more than ten times more likely to develop SAM than children without it. Multicenter studies by Awoke, Ayana, & Gualu, (2018) in Ethiopia have confirmed that decreased food intake and loss of appetite are early indicators of deteriorating nutritional status.

A current case-control study conducted at Al-Sabeen Hospital in Sana'a, Yemen, demonstrated that intractable vomiting is a significant risk factor for severe acute malnutrition (SAM) in children aged 6–59

months. Notably, 36.9% of children in the SAM group experienced persistent vomiting, compared to only 8.5% in the control group. This association was highly statistically significant ($p < 0.000$), with an adjusted odds ratio of 6.28 (Karunaratne et al., 2020; Jabri Maryam et al., 2020) reported that gastrointestinal symptoms, including vomiting, are major contributing factors to SAM in resource-limited settings due to their impact on feeding and nutrient absorption. Talbert et al. (2012) also confirmed that gastrointestinal infections—often accompanied by vomiting and diarrhea—are widespread among malnourished children in sub-Saharan Africa. These conditions lead to a vicious cycle of nutrient loss and impaired digestion, particularly in children with weakened immune systems or those already suffering from malnutrition.

Conclusions

A complex interplay of child-related, parental, dietary, and household factors. Inadequate infant and young child feeding practices, recurrent childhood illnesses, poor access to healthcare services, household food insecurity, and suboptimal WASH conditions significantly contribute to the risk of SAM.

Declarations

Ethics approval and consent to participate: The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The research protocol was approved by The Research Ethics Committee of the Faculty of Medical and Health sciences, AlRazi University, Sana'a Yemen [Approval No: RU/09/FMHS/2024]. All participants provided informed consent prior to inclusion in the study.

Consent for publication: Written informed consent for publication of this study and any accompanying images or data was obtained from all participants. The consent forms are held by [Al-Sabeen Hospital] and are available for review by the Editor-in-Chief of this journal upon request

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Availability of data and materials: Yes, the manuscript contains third party material and obtained permissions are available on request by the Publisher and Data are available from the corresponding author on a reasonable request.

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G,I (First author) conceived and designed the study, collected data, performed statistical analysis, and drafted the main manuscript text.

N.A. (Supervisor) supervised the research process, provided critical guidance, and contributed to manuscript revision.

A.A. data entry.

L.A. data entry.

E.H. data entry

W.A. data collection

A.S. data collection

All authors reviewed and approved the final manuscript.

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Tables

Tables are available in the Supplementary Files section.

Figures

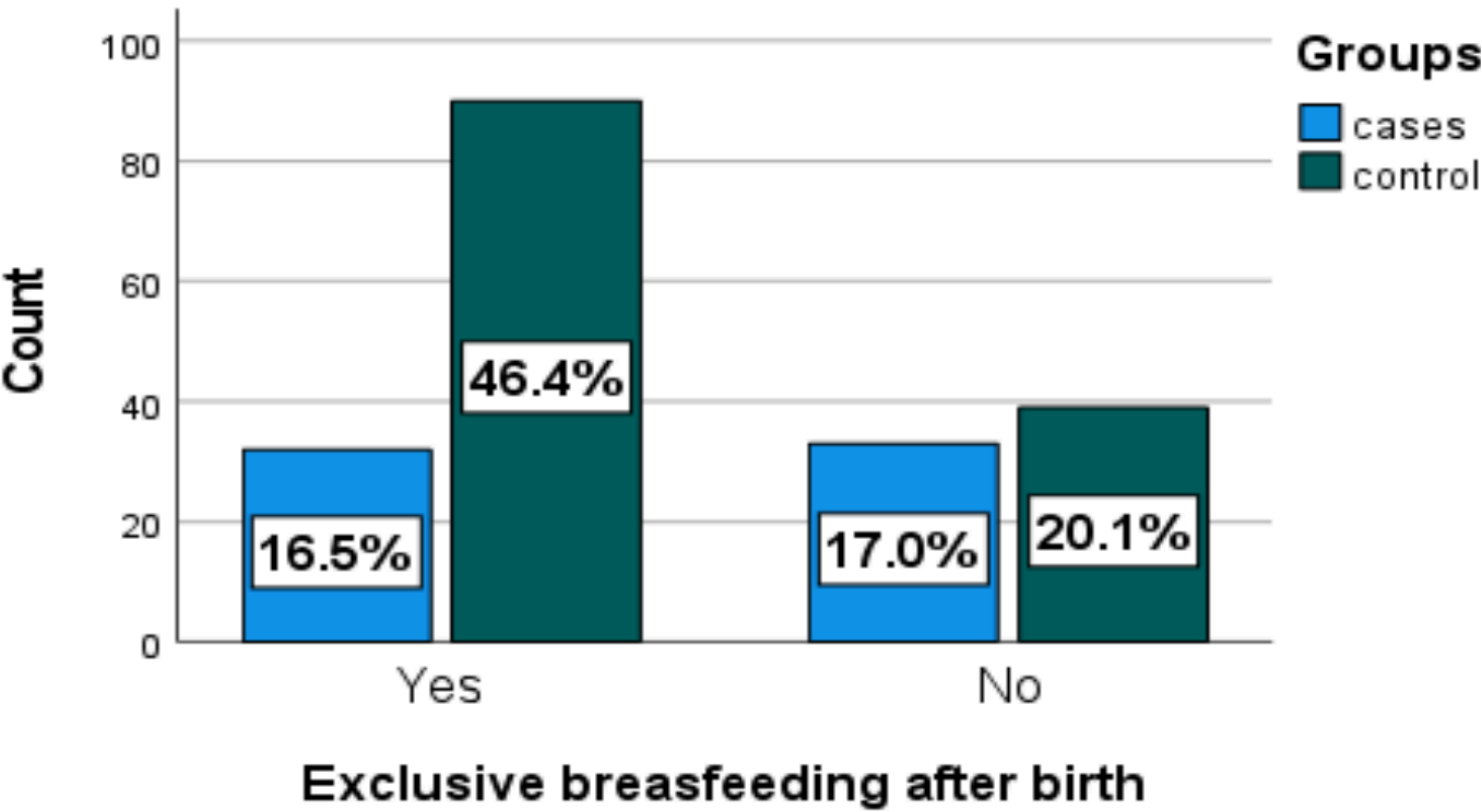


Figure 1

Exclusive breastfeeding after birth among cases and controls groups

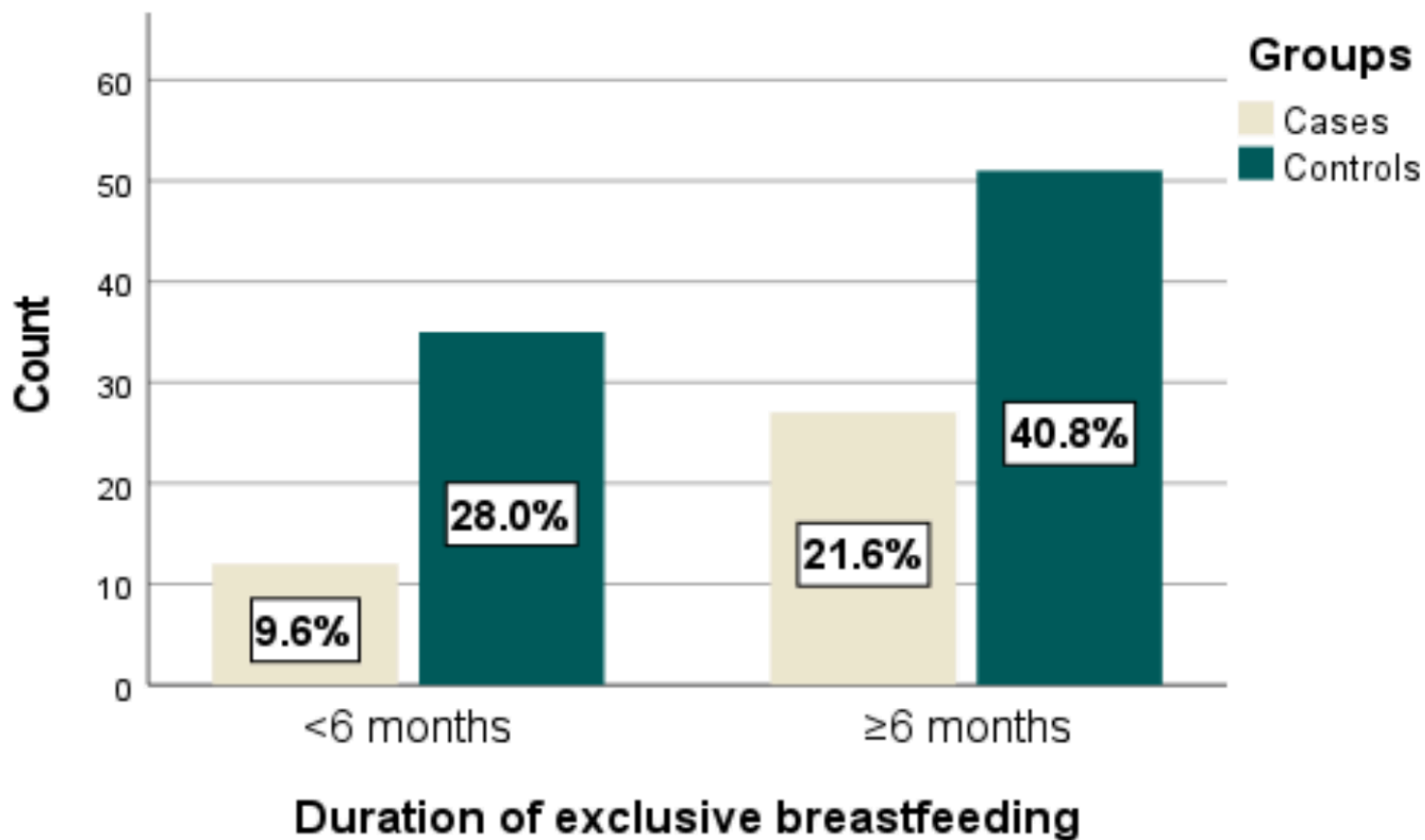


Figure 2

Duration of exclusive breastfeeding among cases and controls groups

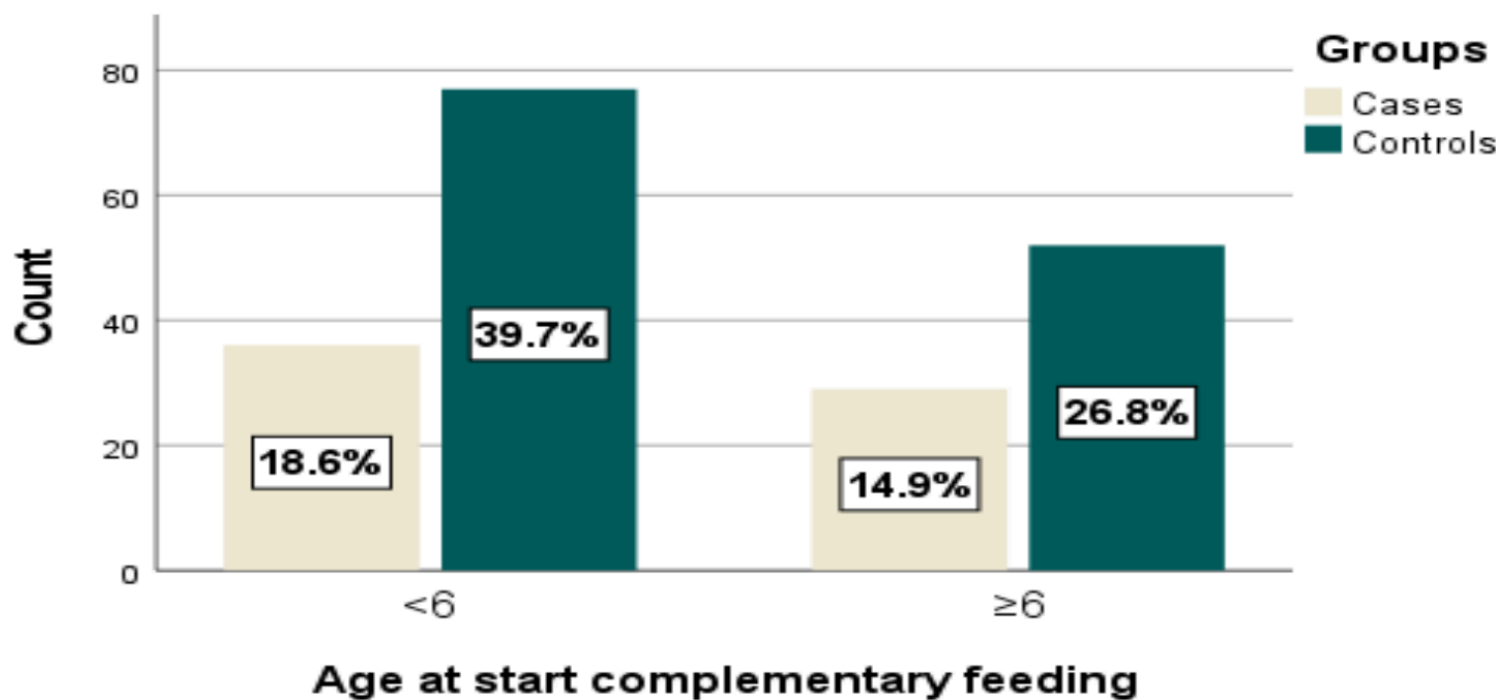


Figure 3

Age at the start complementary feeding among cases and controls groups

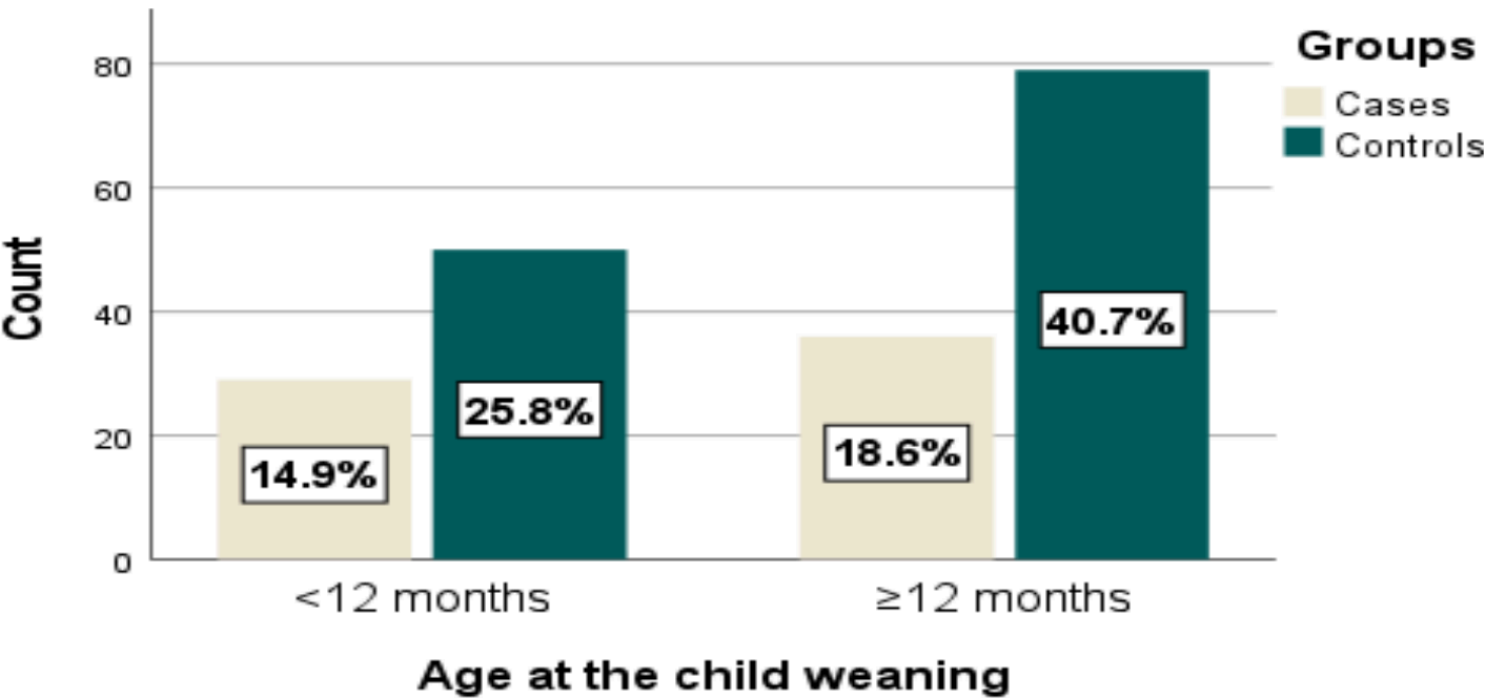


Figure 4

Age at the child weaning among cases and controls groups

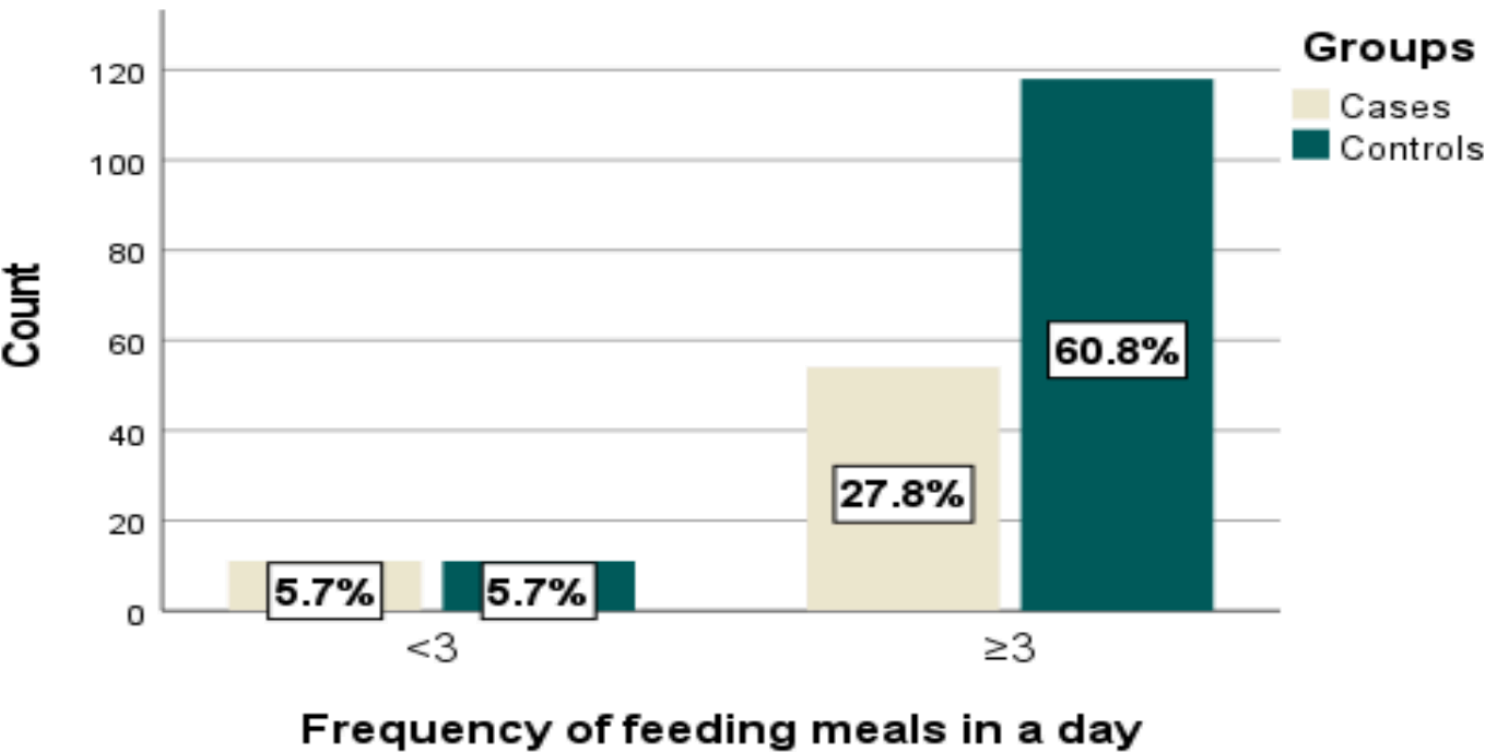


Figure 5

Frequency of feeding meals in a day among cases and controls groups

Supplementary Files

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- [Tablelist.docx](#)