Original Article

Possible effect of maternal safe food preparation behavior on child malnutrition in Benin, Africa

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Abstract Background: In many developing countries, faulty complementary feeding practices and frequently contaminated foods are contributing factors to child malnutrition. The aims of this study were to evaluate the nutrition status of, and clarify the maternal safe food preparation behaviors associated with malnutrition in, children aged <5 years in Cotonou, Benin.

Methods: This study targeted 300 mother–child pairs visiting the University Hospital of Mother and Child Cotonou Lagoon. Mothers were interviewed using a structured questionnaire. Child height/length and weight measurements were determined and Z-scores were calculated using the 2006 World Health Organization Child Growth Standards. Children with Z-score < −2 were considered to have stunting or be underweight. On logistic regression analysis, significant variables on bivariate analysis, the associations of which were clarified in previous studies, were established as independent variables. Approximately 80% of the children who participated in this study were aged < 1 year. Being underweight was analyzed as a dependent variable.

Results: Regarding nutrition status, 11.0% of the children had stunting and 14.7% were underweight. On logistic regression analysis, underweight was correlated significantly with birthweight. As a remarkable point, food refrigeration was statistically significant. Food refrigeration can possibly be regarded as a maternal safe food preparation behavior.

Conclusions: Maternal safe food preparation behaviors can prevent child malnutrition, even after considering biological and socioeconomic factors.

Key words child, malnutrition, safe food preparation behavior.

Malnutrition as an underlying cause of childhood death is associated with infectious disease in developing countries.1 According to State of the World’s Children, published by United Nations Children’s Fund (UNICEF), the prevalence of child malnutrition in Sub-Saharan Africa is particularly high. Specifically, the prevalence of underweight with chronic malnutrition, and of stunting in children aged <5 years old in this region is 21% and 37%, respectively, which is similar to that in developing countries (22% and 37%, respectively).2 In addition, the rate of premature birth 36 weeks of gestation in this same region is 12.3%, which is higher than the average of 8.6% in developing countries. Children with low birthweight or who were preterm have an elevated risk of infectious disease.3 When evaluating child nutrition status, it is necessary to consider birth information such as birthweight and gestational age in weeks, but it can be difficult to obtain these data in Sub-Saharan Africa because the facility delivery rate is not high.2

In many developing countries, faulty complementary feeding practices and frequently contaminated foods are contributing factors to child malnutrition, growth failure, and high morbidity and mortality.2 Complementary foods prepared and stored under unhygienic conditions are often heavily contaminated with pathogens that cause diarrheal diseases and associated malnutrition.5

Several studies addressing the relationship between child malnutrition and poverty have been conducted,6,7 but there have been few studies on the relationship between child malnutrition considering birth information and maternal safe food preparation behaviors in Sub-Saharan Africa. Consequently, the aims of this study were to evaluate the nutrition status and to clarify the maternal safe food preparation behaviors associated with malnutrition in children aged <5 years old who live in Cotonou, an urban area in the Littoral Department of the Republic of Benin.

Methods

Participants

This study targeted 300 mother-and-child pairs visiting the University Hospital of Mother and Child Cotonou Lagoon (CHU-MEL) located in Cotonou, Republic of Benin in Sub-Saharan Africa. Children were at the hospital to receive
pediatric immunizations. The children targeted were those determined by a hospital nurse to be free of diarrhea, fever, or other symptoms, and who were healthy enough to be immunized. The study period was between March and May 2017.

**Measures**

**Mother/child anthropometry**

Physical measurements were taken in accordance with standard protocol as follows. The length of children aged <2 years was measured with the children in the supine position. The weight of the child was measured while wearing thin clothing. The measurement instruments used included an infant length scale with 1 mm units (no. 210; Seca, Hamburg, Germany) for children aged <2 years, a 20 g unit digital scale (no. 1583; Tanita, Tokyo, Japan) for measuring infant weight, a 1 mm unit scale (no. 213; Seca) for measuring the height of mothers and of children aged ≥2 years, and a 100 g unit digital scale (HD622; Tanita) for measuring the weight of mothers and of children aged ≥2 years.

**Maternal structured interview**

Survey forms were prepared with reference to UNICEF-prepared materials and statistical data pertaining to the Republic of Benin. Structured interviews were conducted in regional dialects by local collaborators, and transcripts were translated into French and written on survey forms. Survey question items consisted of the following: mothers’ information (age, religion, education level, ethnic group, mother’s occupation, and mother’s and father’s monthly income); and children’s information, which consisted of (i) birth information (sex, birthdate when unknown, children’s age), birth order, gestational age in weeks, length, and weight (collected from the maternal and child handbook); (ii) vaccination status; (iii) medical history; (iv) maternal safe food preparation behaviors; (v) exclusive breast-feeding and breast-feeding duration; (vi) timing of introducing complementary food; (vii) existence of hand-washing behavior (e.g., before cooking, before eating, and after defecating); (viii) food preservation methods, and (ix) drinking water and existence of a toilet(s).

**Statistical analysis**

Children’s nutrition status was evaluated using the Z-scores in the 2006 World Health Organization (WHO) child growth standards, which are widely used internationally. Z-score was calculated based on a child’s length/height and age using the WHO AnthrocacR tool (Ver. 3.2.2). Children’s nutrition status data were evaluated using their adjusted age (assuming that a baby is born at 40 weeks of gestation) in the case of premature infants (n = 49) born before gestational week 36 for children aged <1 year. Furthermore, 62.3% (n = 187) were <6 months old, of whom 16% (n = 30) were underweight. Compared with children’s nutrition status evaluated using calendar age (i.e. the exact time length after the date of birth), the proportion of stunting was estimated to be 4.7% smaller and that of being underweight to be 3.0% smaller when using the adjusted age (Table 1). Two children were overweight (Z-score ≥ +2).

**Ethics**

This study was conducted with the permission of CHU-MEL (no. 1201, 2016/08/29), which was also used as the study site. This study also obtained the approval of the Ethics Review Board of Okinawa Prefectural College of Nursing (no. 15022, 2016/03/08). The anonymity and confidentiality of the results obtained from this study were guaranteed, after declaring to subjects that these results would not be used for purposes other than the goals of this study and obtaining informed written consent.

**Results**

**Child nutrition status**

Regarding the children’s nutrition status, 11.0% had stunting and 14.7% were underweight, as evaluated using the adjusted age in the case of premature infants (n = 49) born before gestational week 36 for children aged <1 year. Furthermore, 62.3% (n = 187) were <6 months old, of whom 16% (n = 30) were underweight. Compared with children’s nutrition status evaluated using calendar age (i.e. the exact time length after the date of birth), the proportion of stunting was estimated to be 4.7% smaller and that of being underweight to be 3.0% smaller when using the adjusted age (Table 1). Two children were overweight (Z-score ≥ +2).

**Participant characteristics**

Maternal age ranged from 15 to 45 years and the mean age was 29.3 ± 5.62 years old.

Mothers’ monthly income ranged from FCFA3,000 to FCFA5000 000 (n = 194) and the median was FCFA35 000 (approx. USD63). In general, women often do not know their husband’s income in Benin, therefore it is difficult to obtain household income data. The fathers’ monthly income data was
respectively. The rate of low birthweight (LBW) was lower at 9.6% (49.0%) and 153 girls (51.0%), with a mean age of 7.3 months (± 9.65). Most of the children who participated in this study were <1 year old (n = 246, 82.0%). Means birthweight and gestational weeks were 2.9 ± 0.55 kg and 38.0 ± 2.18 weeks, respectively. The rate of low birthweight (<2.5 kg) in the sample was 18.5%. The average birth order was 2.23 ± 1.41, and 39.3% of children were the first child.

With regard to ethnicity, both Fon and Goun accounted for 9% each, and the remaining 82% consisted of 48 ethnic groups. Approximately 60% were Catholic and 10% were Muslim.

The maternal safe food preparation behaviors are listed in Table 2. All mothers responded that they practised hand washing, and they reported using tap water for drinking purposes and having access to a latrine (a simple facility used as a toilet) or toilet. Therefore, these factors were not included in further analysis.

Almost all mothers breast-fed their children until they were 6 months old. Given that only a few mothers responded that they were currently still breast-feeding, such data were not used in analysis.

The percentage of children who had begun eating complementary food was low (37.0%); therefore, the timing of complementary feeding was not included in analysis.

All children had received the necessary vaccinations; therefore, this factor also was not considered in the analysis.

Table 1. Child nutrition status (n = 300)

| Indicators | Z score |  
|------------|---------|  
|            | Mean | SD | n (%) | Corrected age† | Mean | SD | n (%) |
| Stunting‡ | -0.6 | 1.53 | 47 (15.7) | -0.5 | 1.44 | 33 (11.0) |
| Underweight§ | -0.9 | 1.41 | 53 (17.7) | -0.8 | 1.29 | 44 (14.7) |

1Day of birth evaluated as 0 days after birth. †Expected birth date was assumed to be 0 days after the actual birth date in the case of premature infants (n = 49) born before gestational week 36 in children aged <1 year. §Z-score < -2.

Finally, these factors were not included in further analysis, due to the low number of answers received (32.3%).

The children enrolled in the study consisted of 147 boys (49.0%) and 153 girls (51.0%), with a mean age of 7.3 months (± 9.65). Most of the children who participated in this study were <1 year old (n = 246, 82.0%). Means birthweight and gestational weeks were 2.9 ± 0.55 kg and 38.0 ± 2.18 weeks, respectively. The rate of low birthweight (<2.5 kg) in the sample was 18.5%. The average birth order was 2.23 ± 1.41, and 39.3% of children were the first child.

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Almost all mothers breast-fed their children until they were 6 months old. Given that only a few mothers responded that they were currently still breast-feeding, such data were not used in analysis.

On logistic regression analysis, variables that were significant on bivariate analysis and for which associations had been clarified in previous studies (i.e. child’s age and child’s sex) were established as independent variables. We adjusted for socioeconomic variables such as mothers’ monthly income. Mothers’ monthly income data were not used in the analysis because there were too few answers, but mothers’ high income was correlated significantly with fathers’ income (P = 0.004). When limited to those who had complete data on husband’s income (n = 70), only six children had malnutrition, and logistic regression analysis could not be carried out. When, however, the higher income of either the mother or father was used in the logistic regression analysis, the presence of a refrigerator and birthweight were significant (n = 217). Therefore, mothers’ income was used as a socioeconomic variable. Underweight was analyzed as a dependent variable.

Consequently, underweight correlated significantly with birthweight <2.5 kg (OR, 10.108; 95%CI: 3.401–32.542, P < 0.001). As a remarkable point, food preservation was statistically significant (OR, 2.745; 95%CI: 1.031–8.072, P = 0.043; Table 5). Even after considering socioeconomic variables such as mothers’ monthly income, there was a significant association between underweight and these two variables.

Discussion

Maternal nutrition status

Maternal nutrition status groups comprised the following: BMI ≥ 30 (29.0%), BMI 25.0–29.9 (21.7%), BMI 18.5–24.9 (46.6%), and BMI < 18.5 (2.7%). On bivariate analysis, there were no significant differences in maternal education level, occupation, or monthly income according to BMI (Table 3).

Factors affecting underweight

Mothers’ monthly income, birthweight, and gestational weeks were categorized into two groups. Variables that were not significantly associated with underweight were mother’s age, mother’s occupation, mother’s monthly income, mother’s BMI, child’s age (in months), child’s sex, and child’s medical history (Table 4). The correlation coefficient between mother’s monthly income and father’s income was 0.558 (n = 70, P < 0.05; data not shown).

The variables that correlated significantly with being underweight were birthweight (P < 0.001), gestational weeks (P < 0.001), mother’s education level (P = 0.019), and methods of food preservation (P < 0.001; Table 5).

Logistic regression analysis

On logistic regression analysis, variables that were significant on bivariate analysis and for which associations had been clarified in previous studies (i.e. child’s age and child’s sex) were established as independent variables. We adjusted for socioeconomic variables such as mothers’ monthly income. Fathers’ monthly income data were not used in the analysis because there were too few answers, but mothers’ high income was correlated significantly with fathers’ income (P = 0.004). When limited to those who had complete data on husband’s income (n = 70), only six children had malnutrition, and logistic regression analysis could not be carried out. When, however, the higher income of either the mother or father was used in the logistic regression analysis, the presence of a refrigerator and birthweight were significant (n = 217). Therefore, mothers’ income was used as a socioeconomic variable. Underweight was analyzed as a dependent variable.

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Table 2. Maternal safe food preparation behaviors (n = 300)

| Items               | Categories       | n (%) |
|---------------------|------------------|-------|
| Existence of        | Before cooking   | 286 (95.3) |
| hand washing        | Before eating    | 299 (99.6) |
| (duplicate answer)  | After defecation | 299 (99.6) |
|                     | No response      | 1 (0.4) |
| Food preservation   | Refrigerator     | 124 (41.3) |
|                     | Heating, smoking etc. | 170 (56.7) |
|                     | No response      | 6 (2.0) |
| Drinking water      | Tap water        | 284 (94.7) |
|                     | Well             | 8 (2.7) |
|                     | Mineral water    | 7 (2.3) |
|                     | No response      | 1 (0.3) |
| Existence of toilet | Flush toilet     | 84 (28.0)  |
|                     | Latrines         | 208 (69.3)  |
|                     | None             | 7 (2.3) |
|                     | No response      | 1 (0.4) |

Table 1. Child nutrition status (n = 300)

| Factors affecting underweight | n (%)
|-------------------------------|-------|
| Maternal nutrition status     |       |
|                               |       |

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the Cotonou average is half of the national average. The prevalence of underweight in the present children was likely higher than the Cotonou average because 18.4% of the children were premature infants and 16.7% were low-birthweight infants. Benin’s country statistics contain no data on the rate of premature births, but the Cotonou average for low-birthweight is 13.0%. We believe that the fact that the data collection site used for this study was a tertiary referral hospital, equipped with a neonatal intensive care unit, contributed to the high proportion of premature and low-birthweight infants in the present study.

Stunting is regarded as an indicator of chronic malnutrition, and the proportion increases after children are 2 years old. In Benin, the prevalence of underweight in children aged <5 years ranges between 17% and 19% after the age of 6 months; whereas the prevalence of stunting increases to between 47% and 49% after the age of 1 year.

Growth hormones, which are necessary for growth in height, are produced in the muscle tissues, and protein is necessary for muscle development; therefore, muscle growth is

| Table 3 Factors associated with maternal BMI (n = 300) |
|-----------------------------------------------|
| **Variables** | Categories | Total | Maternal BMI (kg/m²) | P-value * |
| | | | ≥30 (n = 87) | ≥25, <30 (n = 65) | ≥18.5, <25 (n = 140) | <18.50 (n = 8) |
| Maternal education level | Elementary school graduation or less | 106 | 23 (21.7) | 27 (25.4) | 52 (49.1) | 4 (3.8) | 0.425 |
| | Junior high school or High school graduation | 102 | 31 (30.4) | 22 (21.6) | 47 (46.1) | 2 (1.9) |
| | Upper high school graduation | 92 | 33 (35.8) | 16 (17.4) | 41 (44.6) | 2 (2.2) |
| Maternal occupation | Yes | 242 | 68 (28.1) | 58 (23.9) | 111 (45.9) | 5 (12.1) | 0.153 |
| | No | 58 | 19 (32.7) | 7 (12.1) | 29 (50.0) | 3 (5.2) |
| Maternal monthly income | ≥35 000FCFA | 100 | 32 (32.0) | 26 (26.0) | 41 (41.0) | 1 (1.0) | 0.564 |
| | <35 000FCFA | 94 | 25 (26.6) | 19 (20.2) | 46 (48.9) | 4 (4.3) |
| | No response | 106 | 30 (28.3) | 20 (18.9) | 53 (50.0) | 3 (2.8) |

*Fisher’s exact test. BMI, body mass index.

| Table 4 Factors associated with underweight (non-significant variables) (n = 300) |
|-----------------------------------------------|
| **Variables** | Categories | Total | Child nutrition status | P-value |
| | | | Z-score ≥ −2 (n = 256) | Z-score < −2 (n = 44) |
| | | | Mean ± SD or n (%) | Mean ± SD or n (%) |
| Mothers | Age (years) | | 29.5 ± 0.35 | 28.4 ± 0.86 | 0.242* |
| | Occupation | Yes | 205 (84.7) | 37 (15.3) | 0.680* |
| | | No | 51 (87.9) | 7 (12.1) |
| | Monthly income | ≥35 000FCFA | 91 (91.0) | 9 (9.0) | 0.053* |
| | | <35 000FCFA | 79 (84.0) | 15 (16.0) |
| | | No response | 97 (91.5) | 9 (8.5) |
| | BMI (kg/m²) | ≥30 | 76 (87.4) | 11 (12.6) | 0.493* |
| | | ≥25, <30 | 53 (81.5) | 12 (18.5) |
| | | ≥18.5, <25 | 121 (86.4) | 19 (13.6) |
| | | <18.5 | 6 (75.0) | 2 (25.0) |
| Children | Age (months) | Male | 130 (88.4) | 17 (11.6) | 0.195* |
| | | Female | 126 (82.4) | 27 (17.6) | 0.145* |
| | Medical history | Yes | 65 (84.4) | 12 (15.6) | 0.604* |
| | | No | 188 (85.8) | 31 (14.2) |
| | Complementary feeding | Yes | 96 (86.5) | 15 (13.5) | 0.808* |
| | | No | 158 (84.5) | 29 (15.5) |

*Fisher’s exact test; t-test. BMI, body mass index.
hindered by chronic protein deficiency.\textsuperscript{18,19} Even children participating in this survey whose nutrition status was not unfavorable also had increasing cumulative nutrition deficiencies as they aged, and we anticipate that these children will also have stunting. As such, conducting a follow-up survey is necessary in the future.

**Maternal nutrition status**

In this study, 29.0% of the mothers had BMI > 30 kg/m\(^2\), which was more than twice the average of Cotonou City (14.6%) according to national statistics.\textsuperscript{10} Mothers with BMI ≥ 30 kg/m\(^2\) tended to have a high education level and high monthly income, but this was not significant on bivariate analysis. Post-partum weight loss is influenced by the degree of weight gain during pregnancy, breast-feeding practise, smoking, and so on.\textsuperscript{20} If the mothers engaged in breast-feeding and returned to work early, they often came back to their pre-pregnancy weight approximately half a year later. In this study, 62.3% of the mothers returned to their pre-pregnancy weight by half a year after childbirth. We did not, however, have data on mothers’ pre-pregnancy weight, but we can guess that BMI is high, given that the final post-pregnancy BMI was still high.

**Birthweight**

Regarding the nutrition status of children born with low birthweight, low-birthweight infants have less developed immune functions than infants born at ≥2.5 kg. In addition, low-weight infants are more susceptible to infection.\textsuperscript{21,22} This low weight is a major cause of infant mortality. According to the WHO, approximately 37% of deaths in children aged <5 years in developing countries occur in neonates, and 74% of neonate deaths are the result of infection or perinatal abnormalities (e.g. premature birth, delivery complications etc.). Low-birthweight infants are susceptible to infection, and contracting a disease can further diminish nutrition status.\textsuperscript{23} According to a report by UNICEF, 45% of deaths of children aged <5 years old is due to malnutrition.\textsuperscript{24} Additionally, low-birthweight infants are already in a state of malnutrition at the time of birth, and simply providing the necessary amount of calories and protein at this stage cannot compensate for this deficiency. Some time is necessary for the infant’s weight to catch up. In the present study, 16.7% of the present children were low-birthweight infants; of these, 70% were premature infants. Although the catch-up growth period needed by premature infants varies, depending on the infant’s individual birth circumstances and subsequent condition, infants in such cases typically catch up with the average growth milestones for their actual age in 1–2 years.\textsuperscript{25} Infants born with a gestational age <28 weeks will require an additional several years to catch up. Given that the average age of the present children was low, at approximately 7 months, and their catch-up development was not yet completed, we believe that birthweight had some effect.

| Table 5 | Factors associated with underweight (significant variables\(^\dagger\)) \((n = 300)\) |
|---|---|
| Variables | Categories | Total | Child nutrition status |
| | | | Z-score ≥ −2 \((n = 256)\) | Z-score < −2 \((n = 44)\) |
| Birthweight (kg) | <2.5 | 50 | 26 (52.0) | 24 (48.0) |
| | ≥2.5 | 220 | 204 (92.7) | 16 (7.3) |
| | No response | 30 | 26 (86.7) | 4 (13.3) |
| Gestational weeks | ≤36 | 55 | 37 (67.3) | 18 (32.7) |
| | ≥37 | 205 | 187 (91.2) | 18 (8.8) |
| | No response | 40 | 32 (80.0) | 8 (20.0) |
| Maternal education level | Elementary school graduation or less | 106 | 83 (78.3) | 23 (21.7) |
| | Junior high school or High school graduation | 102 | 88 (86.5) | 14 (13.7) |
| | Upper high school graduation | 92 | 85 (92.4) | 7 (7.6) |
| Food preservation | Refrigerator | 124 | 117 (94.4) | 7 (5.6) |
| | Heating, smoking etc. | 170 | 136 (80.0) | 34 (20.0) |
| | No response | 6 | 3 (50.0) | 3 (50.0) |

\(^\dagger\)Fisher’s exact test \((P < 0.05)\).

| Table 6 | Significant indicators of underweight \((n = 300)\)\(^\ddagger\) |
|---|---|
| Variables | Categories | OR | 95%CI | \(P\)-value |
| Birthweight | <2.5 kg | 10.108 | 3.401–32.542 | <0.001\(^*\) |
| Gestational weeks | ≤36 weeks | 0.995 | 0.305–2.986 | 0.993 |
| Maternal education level | Elementary school or lower/High school graduation or higher | 1.366 | 0.422–4.769 | 0.607 |
| Food preservation | No refrigerator | 2.745 | 1.031–8.072 | 0.043\(^*\) |

\(^*\)\(P < 0.05\) (logistic regression analysis, malnutrition/normal). \(^\ddagger\)Adjusted by child’s age, sex and mother’s monthly income.
Maternal safe food preparation behaviors

Nearly all the mothers practised hand washing before cooking and eating, and after defecating. Approximately 90% of the mothers began or were considering starting complementary food for their children after 6 months, as recommended by the WHO. In addition, given that the mothers surveyed were having their children immunized, it is believed that the present subjects were highly health conscious.

Approximately 40% of participants responded that food “was kept in a refrigerator”. In Benin, 13.7% of urban households contain refrigerators, which is considerably lower than the 62% of urban households that have a television, and the 78% that have a radio. Malnutrition in infancy is caused primarily by diarrhea, and approximately 70% of this is because of food contamination. Children are also at an elevated risk of developing malnutrition while being weaned from milk to solid food. Families with access to refrigerators capable of preventing bacterial contamination of food used in meals prepared for infants, even when the infants still have weak immune functioning, are at a negligible risk of malnutrition.

Owning a refrigerator or a television is also an economic factor related to nutrition status. There was a significant association between income level of mothers, and mothers who were knowledgeable of their husband’s income. In other words, when the mother knew her husband’s income, the husband’s income was high. This survey did not ask participants about possession of a refrigerator, but we did ask mothers, “How do you keep your food?” to clarify their food preparation behaviors. According to Table 5, it can be suggested that mothers’ food preparation behaviors affected child nutrition status. Taken together, these results suggest that it is necessary to disseminate more information on the importance of safe food preparation behavior, such as organizing education classes for mothers across the whole country.

Limitations

One of the limitations of this study is that we utilized a convenience sampling of mother-and-child pairs who visited CHU-MEL in Cotonou; therefore, the results may be difficult to generalize. In addition, the results are also limited because no quantitative assessment of children’s dietary habits was conducted.

Although the present study has limitations, the strength of this study is that it evaluated and analyzed child nutrition status according to birthweight and gestational age in weeks.

In conclusion, maternal safe food preparation behaviors can prevent child malnutrition even after considering biological and socioeconomic factors.

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Disclosure

The authors declare no conflict of interest.

Author contributions

C.N., Y.K., and T.Y. designed the study and developed the methodology. A.J.V., M.J.A., G.P.B., B.H., and E.A.H. collected the data. C.N., Y.K., and T.Y performed the analysis and drafted the manuscript. All authors take full responsibility for the content of this paper. All authors read and approved the final manuscript.

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