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REGULAR ARTICLE

Most children who took part in a comprehensive malnutrition programme in Madagascar reached and maintained the recovery threshold

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ABSTRACT

Aim: The benefits of including nutritional education in programmes that tackle moderate and severe acute malnutrition remain poorly documented. This study in Madagascar evaluated the nutritional status of children who took part in an innovative programme that included maternal education, on completion and after a year.

Methods: Each year, this outpatient programme admits 2400 malnourished children from six months to 59 months in the lower districts of Antananarivo, Madagascar. Children were drawn by lots, and their anthropometric data were measured. A descriptive retrospective longitudinal study was conducted on 573 children who took part between 2010 and 2013.

Results: The programme lasted an average of 38 days and, on completion, 82.2% had reached the recovery threshold, and 16.2% had moved up to mild malnutrition. This was achieved with food supplements of 720 kcal per day, despite the Malagasy Public Health recommendation of 1000–1500 kcal per day. After one year, 79.1% were still above the recovery threshold, and 15% had mild malnutrition. The recovery rate was higher for children under 24 months of age (odds ratio 2.9, 95% confidence interval 1.93–4.59).

Conclusion: Most children who attended this malnutrition programme with maternal education in Madagascar reached the recovery threshold on completion and had maintained it after one year.

INTRODUCTION

Acute malnutrition affects 52 million children below the age of 5 worldwide (1) and is responsible for around 12% of deaths in this age group (2). In addition, child malnutrition increases morbidity and reduces immune defences and intellectual development. It also increases the probability of being poor in the future (3). These consequences represent important social and economic costs for the affected countries (4). Madagascar has a chronic malnutrition rate of 46% among children below the age of 3 (5,6) and a 13% acute malnutrition rate among those under the age of 5 (7).

In Madagascar, and elsewhere, malnutrition is often treated by programmes that are principally based on dietary supplements (8). A number of studies has aimed to find the most effective nutritional recovery protocols to treat malnutrition (9). However, although a number of international stakeholders stress the necessity of including educational

and nutritional advice in all malnutritional management protocols (10,11), these kinds of interventions remain less studied (12). In addition, as the real challenge of a programme against malnutrition is to maintain acceptable recovery rates in the long term, there is a lack of information about long-term outcomes for postprogramme beneficiaries (13).

In this retrospective longitudinal study, we aimed to evaluate changes in the nutritional status of moderately

Abbreviations

ANOVA, Analysis of variance; OR, Odds ratio; UNICEF, United Nations International Children's Emergency Fund; WHZ, Weight-for-height Z-score.

Key notes

- The benefits of including nutritional education in programmes that tackle moderate and severe acute malnutrition remain poorly documented.
- We studied 573 children aged six months to 59 months in Madagascar who took part in a nutrition programme that included maternal education and lasted an average of 38 days.
- Most of the children (82.2%) reached the recovery threshold when they completed the programme, and 79.1% had maintained it after one year.

malnourished children who received a nutritional programme based on the distribution of enriched flour, with particular reference to the maternal educational aspects. This study used data when the programme was completed and one year later. Our hypothesis was that the children who took part in the programme would be able to maintain an acceptable nutritional status due to the education their mothers received from the programme.

METHODS AND PARTICIPANTS

Location and programme design

Each year since 2006, this comprehensive outpatient programme, which combines food supplements and nutritional education, has admitted 2400 malnourished children from the lower socioeconomic class districts of Antananarivo, the capital of Madagascar. It is a poor urban environment that could be described as a slum. The criteria for the definition of malnutrition used by the programme are based on the weight-for-height Z-score (WHZ), 2006 version, recommended by the World Health Organization (14) and by the Malagasy Ministry of Public Health (15). The children's nutritional status is graded as recovery (WHZ ≥ -1), mild acute malnutrition (WHZ < -1 et ≥ -2), moderate acute malnutrition (WHZ < -2 and ≥ -3) and severe acute malnutrition (WHZ < -3). This programme follows the Malagasy Ministry of Public Health recommendations for community involvement, screening, admission criteria, recovery criteria, vaccine update status and the treatment of associated pathologies (4,15). The only exception was that this programme did include some children with severe acute malnutrition during the study period, unless they presented with complications such as oedema or lack of appetite, during the study period. Although this was not an official admission criteria, other opportunities for the rehabilitation for severe acute malnourishment in children were not otherwise available in this area. We therefore also decided to include them in our analysis.

Nutritional screening is undertaken weekly by the local community workers in the districts by measuring the children's mid-arm circumference. Then, an evaluation of the screened children is carried out by the nutritional assistants using the WHZ indicator and whether oedema is present. The children with oedema and, or, a marked lack of appetite are referred to hospitals. All the local community workers and nutritional assistants are trained by the French Association L'APPEL, which is an international solidarity association that has supported local childhood initiatives since 1968 (16). The admission criteria are children from six months to 59 months with a WHZ of between <-2 and ≥ -3. The children meeting the programme criteria and an accompanying person, usually the mother, join a group of about 20 children for a 35-day programme. They take part in a weekly session organised by the nutritional assistants and the local community workers in their districts, for example, in a classroom or room provided by free by the districts or by a richer citizen or in the square in front of a

church. The sessions last around two hours and included: anthropometric measures such as weight, height, WHZ and control for oedema; information, education and counselling for the accompanying person; a cooking demonstration; the on-site consumption of one portion of cooked Koba Aina, an enriched flour (Taf, Antananarivo, Madagascar) and the distribution of Koba Aina for the week ahead. This dry complementary food has a high nutritional quality, and 99% of the ingredients are from local raw materials: corn flour (49.6%), red rice flour (15.0%), soya flour (15.6%), peanut flour (7.5%), sugar (11.0%), iodised salt (0.7%), mineral salts and vitamins (0.6%). Each 100 g of the flour contains 360 kcal, 10.9 g of proteins, 8.4 g of lipids, 23.3 mg of iron and 219 mg of calcium together with zinc and vitamin A (17). Each child received 200 g per day. The nutritional supplementation has therefore been reduced to 720 kcal per day, compared with the 1000–1500 kcal per day recommended by the Malagasy Ministry of Public Health (15), in favour of providing more nutritional and general education.

The education component of the programme was based on the Nutricartes (16) participatory pedagogical method, which was developed by L'APPEL. The pedagogical support comprised two inseparable games, each made up of a game board and picture cards. The first focused on education with regard to a balanced diet and represented the three essential food groups that should constitute a correct meal: energy, proteins and vitamins. These were called as energy, construction and protection, respectively, and the picture cards represented local market foods. The other game board concentrated on good practice with regard to hygiene, drinking water and prevention, and the picture cards showed behaviours that were and were not recommended, such as washing hands and defecating outside proper toilets. The pedagogical games were carried out in small groups of 5–10 mothers, and active participation was encouraged. Each group was given a game board and picture cards to play with. One nutritional assistant, who received regular training from L'APPEL, led each game, explaining the game, the rules, the food groups and their roles. Then he distributed the cards, asked all the mothers to place their cards one after the other and interacted with them until they provided the correct answers. The information, education and counselling focused on the fact that giving the child diverse healthy meals that provided sufficient protein was possible and affordable. The themes addressed follow plans supervised by the doctor and L'APPEL. As well as the weekly sessions, the programme also provided an update of the children's vaccination status, free healthcare from the programme doctor, parental support and information on family planning. Breastfeeding was also encouraged.

The children finished the programme once they had reached the recovery threshold of WHZ > -1 and completed a minimum of four week's education. The nonrespondents were those who do not reach this level in three months. A year after the programme, the files on two children were drawn by lots from each cohort of 20

children, to enabled random sampling to take place. A nutritional assistant and a local community worker went to the home of the selected children, measured the anthropometric data and filled out a questionnaire covering personal, socio-economic, clinical, food and general data. This questionnaire was created by Malagasy doctors in 2010. The children were weighed in their underwear with a Salter UNICEF hanging scale (Brecknell, Fairmont, MN, USA). The children's height was measured by a minimum of two people. Following UNICEF's standards, the children were measured without their shoes on, with their legs straight and with a centimetre dropdown against a flat vertical plane. The children over two years of age were standing up, and the younger children were lying down.

Study design and participants
In this descriptive retrospective longitudinal study, we used one-year follow-up data and all the questionnaires completed between 2010 and 2013 were included. We choose 2010 because the process of drawing by lots had improved from that year, and 2013 was when the data collection took place. The children who were admitted with moderate and severe acute malnutrition were included, and questionnaires containing irretrievable data were excluded (Fig. 1).

This study was approved by the Department of Health of the Child, of Mothers and of Reproduction, which is part of the Malagasy Ministry of Public Health.

Procedures
The data were entered by an external project collaborator and processed in a strictly anonymous manner. We recalculated the WHZ of each child at the time of admission, at the end of the programme and one year after the programme with STATA software, version 11.0 for Windows (Microsoft, Washington, DC, USA). The basis of the calculations was the 2006 World Health Organization growth curves (14). Of the 622 questionnaires that were collected, 4.7% were excluded because the children had a WHZ of ≥-2, which did not correspond to the
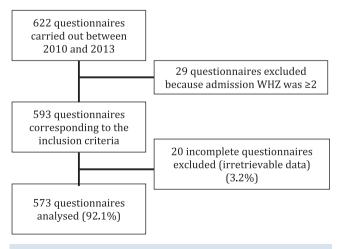
anthropometric criteria for inclusion in the study (Fig. 1). Even if in practice their admission could be justified, for example because they were borderline cases, we excluded them from the analysis so that we did not skew the results. The verification of the database revealed a few entry errors or missing dates. Most were corrected by going back to the paper documents, but 20 questionnaires (3.2%) had to be excluded because of irretrievable data. A total of 573 forms were analysed. Apart from the anthropometric variables, only a minority of items from the questionnaire were considered to be sufficiently reliable for the analysis. The primary outcomes were, therefore, the change of WHZ at the time of entry, on completion of the programme and one year after the programme. The secondary outcome was the change of nutritional status one year after the programme.

Statistical analysis
To examine the variable distribution, we computed means and standard deviations for continuous demographic variables and frequencies and percentages for categorical variables. We conducted analysis of variance (ANOVA) tests for continuous variables and exact Pearson's chi-square tests for categorical variables. We performed multiple linear regression models to examine the associations between recovery rates and WHZ. We used WHZ as the primary outcome. In the multivariable models, we included only those covariates that were of *a priori* interest of univariate analysis. The final multivariable models included WHZ upon admission, age, gender, exit WHZ and water treatment. All the tests were two-sided, and the results were considered significant at 0.05. Statistical analyses were performed using STATA 11.0 for Windows.

RESULTS
The study participants were all aged between six months and five years at the time of their admission, as recommended by the Malagasy Ministry of Public Health, except for one child who was five months old (0.02%) (Table 1). On average, the length of time the children received nutritional care from the programme was 38 days. The majority of the children (94.4%) had been admitted with moderate acute malnutrition, which corresponds to the inclusion criteria for the programme recommended by the Malagasy Ministry of Public Health. Furthermore, 5.6% of the children admitted with severe acute malnutrition completed the sample.

At the end of the programme (Table 2), 82.2% of the children met the recovery criteria, and 16.2% had progressed up to mild acute malnutrition, which was an important improvement in their nutritional status. The recovery rate was higher among children admitted with moderate acute malnutrition (83.9%) than those admitted with severe acute malnutrition (53.2%) (p = 0.0001) (Table 2). Those with moderate acute malnutrition were also with four times more likely to achieve the recovery threshold than those with severe acute malnutrition, with an odds ratio (OR) of 4.0 and 95% confidence interval (95% CI) of 1.89–8.81 (Table 3).

Figure 1 Flow chart of participants' registration.

The flow chart shows:
- 622 questionnaires carried out between 2010 and 2013
- 29 questionnaires excluded because admission WHZ was ≥2
- 593 questionnaires corresponding to the inclusion criteria
- 20 incomplete questionnaires excluded (irretrievable data) (3.2%)
- 573 questionnaires analysed (92.1%)

Table 1 Characteristics of participants

	Number	%
Participants	573	100.0
Age at admission		
Less than six months	1	0.2
<12 months	178	31.0
12–24 months	215	37.6
>24 months	179	31.2
Median (month ± IQR[2])	18 ± 17	
Z-score upon admission		
Moderate malnutrition (WHZ < −2 and ≥−3)	541	94.4
Severe malnutrition (WHZ < −3)	32	6.6
Length of care		
Average (days)	38 (range 15–127)	
Median (days)	35	
Missing data	20	3.5

WHZ = Weight-for-height Z-score.

Table 3 Odds ratios (OR) of recovery rates according to the Z-score upon admission, age upon admission, exit Z-score and water treatment in univariate analyses*

	Univariate analysis (n = 569)		
	OR	95% CI	p-Value
Recovery at the time of exit			
Category of Z-scores on admission			
Moderate malnutrition	4.0	1.89–8.81	<0.01
Severe malnutrition	Ref	–	
Age			
<24 months	1.7	1.11–2.75	0.011
>24 months	Ref	–	
Gender			
Girls	2.1	1.33–3.27	<0.001
Boys	Ref	–	
Recovery at one year postprogramme			
Category of Z-scores on admission (n = 567)			
Moderate malnutrition	2.6	1.25–5.74	0.019
Severe malnutrition	Ref	–	
Age (n = 567)			
<24 months	2.9	1.93–4.59	<0.001
>24 months	Ref	–	
Gender (n = 567)			
Girls	1.1	0.72–1.66	0.658
Boys	Ref	–	
Exit Z-score (n = 564)			
Recovered	2.1	1.32–3.54	0.001
Not recovered	Ref	–	
Water treatment (n = 560)			
Boiling	1.1	0.64–1.97	0.692
Chlorination	1.8	1.12–2.95	0.015
No treatment	Ref	–	

OR = Odds ratio; Ref = References; CI = Confidence intervals.
*The number of data analysed excludes the missing data.

One year after the children completed the programme (Table 2), the global recovery rate was still 79.1%. In addition, nearly 15% more children were classified as having mild acute malnutrition. Statistically, the children admitted with moderate acute malnutrition were more likely to reach the recovery threshold than those admitted with severe acute malnutrition with an OR in the univariate analysis of 2.6 (95% CI 1.25–5.74) (Table 3). A significant difference also existed between the nutritional status of children after one year, according to their exit WHZ. Children who had recovered at the time of exit were more than twice as likely to maintain that recovery after one year (OR 2.1, 95% CI 1.32–3.54) (Table 3).

Table 2 Evolution of WHZ of children at the time of exit from the programme and more than one year later

		Total (n = 573) n (%)	Admitted in moderate malnutrition (n = 541) n (%)	Admitted in severe malnutrition (n = 32) n (%)	p-Value*
Exit					
Recovery	WHZ ≥ −1	471 (82.2)	454 (83.9)	17 (53.2)	<0.001
Mild malnutrition	WHZ < −1 and ≥−2	93 (16.2)	81 (15.0)	12 (37.5)	0.003
Moderate malnutrition	WHZ < −2 and ≥−3	3 (0.5)	3 (0.5)	0 (0.0)	0.682
Severe malnutrition	WHZ < −3	2 (0.4)	1 (0.2)	1 (3.1)	0.004
Missing		4 (0.7)	2 (0.4)	2 (6.2)	
One year postprogramme					
Recovery	WHZ ≥ −1	453 (79.1)	434 (80.2)	19 (59.4)	0.019
Mild malnutrition	WHZ < −1 and ≥−2	85 (14.8)	78 (14.4)	7 (21.9)	0.223
Moderate malnutrition	WHZ < −2 and ≥−3	20 (3.5)	16 (3.0)	4 (12.5)	0.003
Severe malnutrition	WHZ < −3	9 (1.6)	8 (1.5)	1 (3.1)	0.453
Missing		6 (1.0)	5 (0.9)	1 (3.1)	

WHZ = Weight-for-height Z-score.
*The comparison was carried out between the children admitted in moderate and severe acute malnutrition only, according to a univariate analysis with STATA 11.0.

According to the univariate analysis (Table 3), the recovery rate was statistically higher for children younger than 24 months old than for children older than 24 months old, at the end of the programme (OR 1.7, 95% CI 1.11–2.75) and one year after the programme (OR 2.9, 95% CI 1.93–4.59). The recovery rate was also better among children who came from families that used chlorination to treat water, who were 1.8 times more likely to have maintained their recovery at one year than those who came from homes that did not treat their water (OR 1.8, 95% CI 1.12–2.95). Gender also influenced the recovery rate at the time of exit from the programme, but not when the follow-up survey was carried out.

The multivariate analysis (Table 4) confirmed the significant effect of age, admission WHZ and gender on the recovery rate at the time of exit from the programme. The multivariate analysis also demonstrated that age, admission WHZ and water treatment significantly influenced the nutritional status at one year after the programme, while gender no longer played a significant role at that time. Contrary to the result of the univariate analysis, in the multivariate regression the effect of the exit WHZ was no longer significant, with a p-value of 0.052, which was close to the arbitrary significant cut-off of <0.05. The exit WHZ could, therefore, have had an impact on the long-term nutritional status of the children, but further studies would be necessary to confirm this.

DISCUSSION

The principal objective of this study was a one-year follow-up of the nutritional status of children who benefited from a programme that had a particular focus on maternal education. The strength of this study was that it is focused on the long-term future of the beneficiaries, with anthropometric data rigorously measured by an experienced team regularly supervised by L'APPEL. Indeed, studies on this specific area remain sparse because of numerous difficulties, such as finding children for long-term follow-ups and obtaining reliable data in the field (13,18).

Results at the end of the programme

The results of this study suggest that this comprehensive programme enabled a good recovery rate, because 82.2% of the children had recovered, and about 15% of the children were classified as having mild acute malnutrition at the time of exit. These results were compared to the Sphere norms, which are internationally recognised sets of universal minimum standards for the delivery of a quality humanitarian response and are used as a reference by the Malagasy Ministry of Public Health (15). The 2011 version of the Sphere norms recommend that, for moderate acute malnutrition, the percentage of children who have recovered at the end of a treatment programme should exceed 75%. These results are even more promising, when you consider that the recovery rates at the time of exit from different nutritional recovery programmes have generally been between 59% and 80%, depending on the studies (12,19). This range has been wide because the protocols differed, such as the supplementation dose, the importance of the educational sessions and the length of the follow-up study. Moreover, it is important to mention that the recovery criteria differed between the few published studies. Indeed, certain authors used WHZ > −2, which was a lower threshold than in the present study (WHZ > −1). Finally, in Madagascar, centres treating moderate acute malnutrition reported an average recovery rate of 65% (20), which proves that nutritional supplementations are not the only measure of success, especially in such a complex context.

Follow-up results one year after the programme ended

One year after the programme ended, the recovery rate (79.1%) still exceeded the Sphere recommendations, even

Table 4 Odds ratios (OR) of recovery rates according to the Z-score upon admission, age upon admission, exit Z-score and water treatment in multivariate analyses*

	Multivariate logistic regression		
	aOR	95% CI	p-Value
Recovery at the time of exit (n = 569)[†,‡]			
Category of Z-scores on admission			
Moderate malnutrition	4.6	2.08–10.09	<0.001
Severe malnutrition	Ref	–	
Age			
<24 months	2.0	1.23–3.13	0.004
>24 months	Ref	–	
Gender			
Girls	2.0	1.29–3.17	0.002
Boys	Ref	–	
Recovery at one year postprogramme (n = 557)[‡,§]			
Category of Z-scores on admission			
Moderate malnutrition	2.6	1.13–5.96	0.024
Severe malnutrition	Ref	–	
Age			
<24 months	3.2	2.07–5.04	<0.001
>24 months	Ref	–	
Gender			
Girls	1.2	0.76–1.86	0.422
Boys	Ref	–	
Exit Z-score			
Recovered	1.7	0.99–2.85	0.052
Not recovered	Ref	–	
Water treatment			
Treatment	1.2	1.01–1.42	0.031
No treatment	Ref	–	

aOR = Adjusted odds ratio; CI = Confidence intervals; Ref = References.
*The number of data analysed excludes the missing data.
[†]Number of participants with data for each item studied in the multivariate analysis.
[‡]Factors used in multivariate analyses for the recovery at the time of exit are: the Z-score upon admission (Ref: severe malnutrition); age (Ref: >24 months); gender (Ref: boys).
[§]Factors used in multivariate analyses for the recovery at one year postprogramme are: the Z-score upon admission (Ref: severe malnutrition); age (Ref: >24 months); gender (Ref: boys); the exit Z-score (Ref: not recovered) and water treatment (Ref: no treatment).

though the Sphere norms do not provide any specific recommendations for the long-term recovery. The recovery rate a year after the programme finished was also compared with other published studies. For example, Trehan et al. reported that 63–71% of children had maintained their recovery (WHZ > −2) from moderate acute malnutrition one year after their, which combined fortified foods and intensive nutritional counselling (8). However, this comparison is problematic because the study was carried out in Malawi where HIV rates are quite high. Other authors (13,18) tried to conduct long-term, follow-up studies, but their outcomes were not really comparable to ours, except for weight gain or average WHZ scores. This reflects the difficulties of conducting fieldwork in these contexts.

Finally, it is reiterated that the context is complex and that malnutrition in Madagascar is multifactorial, due to factors such as poverty, poorly adapted nutritional practices and lack of access to drinking water (20). However, nearly eight of 10 children had recovered when they finished this outpatient programme, and maintained that recovery one year after the programme ended, and this was due to a number of factors. They included the nutritional and general educational sessions based on the Nutricartes methodology, the distribution of nutritional supplements, the updates on vaccine status and parental support. This comprehensive programme aimed to respond as fully as possible to the complexity of the context.

Methodological aspects and limitations

Two important elements of the malnutrition follow-up were not fully addressed in this study: the presence of oedema and also disabilities, which are potential causes of malnutrition. This can be explained by the fact that when such cases were identified, they were referred to hospitals.

Moreover, certain methodological aspects of our study derive from the complexity of the context of the lower socioeconomic class districts of Antananarivo. For example, a perfectly randomised selection is almost impossible or would require disproportionate human and financial resources. The intention in this context was to obtain the most representative population sample possible. The children identified by the nutritional assistants and local community workers came from the 12 districts where the programme is carried out. However, at the follow-up stage, it was not possible to locate all the previously selected children, and they were replaced by other children from the nearest neighbourhood who had previously benefited from the programme. This enabled us to pursue the research despite the real context, which is called operational design.

This entailed certain limitations. For example, the fact that the children who were not found were not documented prevents us from knowing the true magnitude of the phenomenon and from determining the mortality rate among these children. Another limitation was that the observational study design used the existing data retrospectively, which only enabled us to highlight certain tendencies. To prove the effectiveness of this programme, a randomised controlled trial would be the gold standard.

Nevertheless, the most interesting perspective was also to try to understand the underlying mechanisms that explained these positive results.

CONCLUSION

In conclusion, this study found that this comprehensive outpatient programme, which puts a strong emphasis on the Nutricartes model of nutritional education, seemed to contribute to the long-term maintenance of an acceptable nutritional status of children under the age of 5. These results were possible even though the quantity of flour was 30–50% below the national recommendations. This is interesting, as the flour is the most expensive part of these kinds of nutritional programmes. These results have recently motivated a further reduction of the quantities of flour distributed. Future studies will be able to evaluate this choice.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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