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Original article

A hand-made supplementary food for malnourished children (*)

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Summary. We tested the possibility to prepare a hyperproteic and hyperenergetic supplementary food for malnutrition rehabilitation in children starting from available ingredients in popular markets in Sierra Leone. Twelve residents in Paediatrics from University of Parma, Italy, prepared in a hospital near the capital Freetown with modest technology a mixture of peanut flour, palm oil, milk powder, sugar and vitamins to which they gave the name of "Parma pap". Three hundred and thirty-two malnourished children (mean age 14±6.3 months) who were receiving Feeding Program Supplementations (FPS), were enrolled in the study: 177 participants received randomly FSP portions only (Group 1), and 159 participants were treated with FSP regimen plus a supplement of "Parma pap" (Group 2). Outcomes of the study were computed as WHZ-score increment (Δ value) by subtracting the discharge WHZ-score from the admission WHZ-score. The best Δ-WHZ-scores (>+4) were recorded among participants of Group 2 (64%) rather than in Group 1 (21%; p=0.040). The children receiving FSP portions plus "Parma pap" recovered faster (5.54 week on average) than those treated with FSP regimen only (8.16 on average). The percentage of children who did not recover was higher in Group 1 (25.3%) than in Group 2 (; 13%; p=0.05). A slight positive correlation has been found between WHZ-scores at admission and at the end of the study (r=0.19; p=0.045). During the experience in Sierra Leone we have had the chance to give "Parma pap" to twenty one malnourished children admitted to Xaverian Mission in Makeni, northern Sierra Leone, not taking other supplementary food. Sixteen of these children recovered in 4.9 week on average and five in 6 to 8 weeks. Mean Δ-WHZ-scores ranged between + 1 and + 5. The data from the present study suggest that "Parma pap" could be an effective additional food to FPS regimen in malnutrition recovering. Further researches are needed on the contrary to prove if "Parma pap" could be defined as a veritable ready to use therapeutic food, although this characteristic seems already to result from the experience in Makeni Mission. (www.actabiomedica.it)

Key words: malnutrition, malnourished children, RUTF

Introduction

It has been estimated that child malnutrition in poor countries is one of the leading causes of all child deaths under the age of 5 years (1). Due this dramatic situation, the World Health Organization (WHO) has launched standard procedures consisting in a preliminary administration of milk-based liquid food moderately rich in protein and energy (called F-75), completed with a high-energy, high-protein milk-based

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liquid meal (F-100) when a significant body weight gain has been attained after F-75 treatment (2). Because milk is a food not always available out the hospital, supplementary feeding at home composed of cereal and legumes has been also experimented to counteract malnutrition (3,4). A hyperproteic and hyperenergetic ready-to-use therapeutic food (RUTF), characterised by a nutritional profile similar to the traditional F-100 but with a higher energy density (> 5 times F-100), has been recently introduced for childhood malnutrition treatment (5-7). The most known RUTF is a commercial energy-dense paste produced by Nutriset, France, that consists of milk powder, vegetable oil, sugar, peanut butter, vitamins and minerals (8). This RUTF resulted to be effective in achieving recovery from childhood malnutrition in disadvantaged countries like in Malawi (9,10). However, it has been reported to have three weak points: it is industrially made, is expensive for a community without income, and is extraneous to local customs (11).

Given these considerations we evaluated the possibility to prepare a RUTF from locally available ingredients that could be autonomously prepared in humanitarian centres, missions, infirmaries and wherever there was an ongoing program against malnutrition.

We chose to implement our plan in one of the poorest areas of the planet, the Sierra Leone, where malnutrition rate is reported among the highest in the world (12). At the hospital of "G", a poor neighbourhood town on the eastern end of the capital Freetown (of which we report only the initial name "G" as the Health Department of the hospital asked not to be named in this study), twelve residents in Paediatrics from Parma have each spent an internship of three months from 2009 to 2012, and had the chance to prepare with modest technology a supplementary food for malnourished children recruited in the villages around hospital. On the basis of the information collected *in loco*, the residents had known that peanuts and palm oil were the least expensive and the most readily available ingredients to prepare a hyperproteic and hyperenergetic supplementary food. Starting from these two popular ingredients, the residents in Paediatrics have prepared a mixture of peanut flour, palm oil, milk powder, sugar and vitamins to which they gave the name of "Parma pap".

During the stay at "G" hospital, a resident has had the chance to operate also in the Xaverian Mission in Makeni, a northern province of Sierra Leone, and to treat malnourished children with only "Parma pap" during the stay in the Mission infirmary.

Herein we evaluated the effect of this hand-made supplementary pap on the recovery of malnourished children both in "G" hospital and in Makeni, Sierra Leone.

Patients and methods

Patients

Children aged 6-60 months with of a moderate malnutrition degree - defined as having a weight-for-height z-score (WHZ) of -3.0 to less than -2.0 SD, corresponding to a body weight for height of > 70 but < 80% of the standard reference values of WHO (13) - were considered eligible for this study. Enrollment was done from July 2009 to July 2012 in the infirmary of "G" hospital. Children affected of an acquired chronic disease were excluded from the study.

All screened participants were receiving United Nations World Food Programme Supplementations (FPS) made with corn flour, palm oil, dried fishes and milk powder. The ration for one child provided a maximum of 1000 to 1200 kcal/person/day and 10-12% of energy from protein. At the time of being admitted to the study, children were randomly distributed into two groups. Group 1 included children fed with FPS regimen only, and Group 2 those children who received FPS regimen plus a supplement of "Parma pap". For ethical reasons and cultural beliefs it was not possible to suspend FPS regimen in the Group 2 children.

The recruitment was personally managed by the residents of the post-graduate School of Paediatrics, University of Parma, Italy, during their stay in hospital. The young residents worked under the responsibility of a senior Paediatrician working at the same hospital.

"Parma pap"

"Parma pap" ingredients were constituted according to the typical recipe for a RUTF by peanuts (25%),

sugar (28%), palm oil (15%), milk powder (30%), mineral vitamin mix (1.6% weight). Peanuts, brown sugar and palm oil were found at the market of "G". Milk powder was locally found, vitamins and minerals were provided by Watson Inc. (West Haven CT, USA). The pap was produced using a basic technology imported from Parma, Italy, and consisting in a mixture and shaker machine, a scale and a sealing machine. Mixer and shaker machine could also be operated by a hand crank in case of a lack of electricity. The machines were cleaned with soap and water, and carefully dried before using. All ingredients were stored in a clean area and all workers were stimulated to dry their hands and wear clean plastic gloves before and during pap preparation.

A progressive mixing procedure has been followed in order to obtain a homogeneous pap. Sugar and peanuts were separately mixed to obtain a powder and a paste respectively. Sugar powder was enriched with milk, vitamins, and minerals powder. Palm oil was finally added to sugar powder and peanuts paste. All ingredients were stirred at high speeds for ten minutes in a mixer machine (detail of procedures available at the Authors address). Formula and procedures were standardized by the researchers from Food Sciences Department, of University of Parma, Italy.

The homogeneous paste thus obtained was divided into servings of 100 g each and packaged in sealed plastic bags to be delivered to mothers (Figure 1). Thank to this mixture we was able to give children a supplement serving useful to attain the amount food corresponding to a daily 200 Kcal/kg/day, according to the WHO (14). The mothers of participants to the study were involved in pap preparation.

Figure 1. A 100 g serving of "Parma "Parma pap" packaged in a sealed plastic bag

In addition to the scheduled amount of FPS, each mother of Group 2 children was given a number of 100-g servings of "Parma pap" equal to the weekly requirement established by the scheme reported in Table 1. The first serving was administered in out-patient clinic regimen in order to monitor possible side effects concerning manifestations of food allergy and to aid the mother to properly administer and manipulate a serving-pap (Figure 2). To obtain a further "Parma pap" week supply, the mother of the Group 2 children had to return to the out-patient clinic with the empty pap's containers.

At out-patient clinic, weight and length were weekly measured in both Group children, and the mothers were questioned whether the children had consumed distributed foods well. The clinical follow-up lasted for 12 weeks, after which all children were discharged. A child has been considered as "winner" if he had attained a WHZ value of -1.0 to less than -2.0 (80-90 % of the expected body weight for height).

Table 1. Demographic characteristics and WHZ-scores distribution at recruitment in both two children Groups

Characteristics	Group 1 (*)	Group 2 (**)
Patients number	177	159
Age (months)	14.0±6.3	15.1±5.2
Weight-for-height-z-scores	-2,46±0,86	-2,34±0,76
M/F	79/98	76/83

(*) participants receiving FSP portions only, (**)participants receiving FSP and "Parma pap" portions

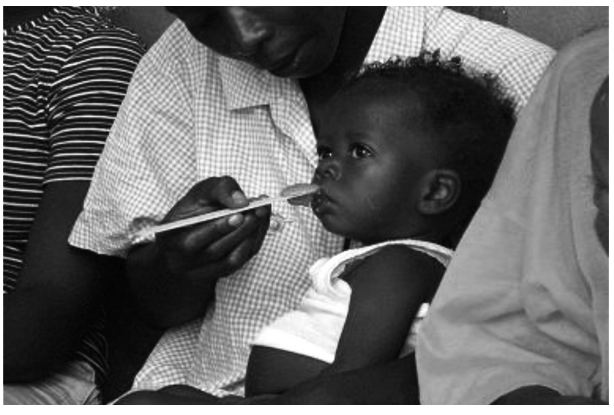

Figure 2. First serving was administered in out-patient clinic regimen in order to monitor possible side effects.

Children who reached this goal before the planned 12 weeks of treatment were discharged in advance.

During the experience in "G" we have had the chance to give "Parma pap" to ten malnourished children admitted to Xaverian Mission in Makeni, northern Sierra Leone, not taking other supplementary food. The pap was prepared in Makeni according to the same formula and the same manner as in "G" under the guidance of one of the authors of this article (F.M.). This satellite experience allowed us to evaluate pap effectiveness as a veritable RUTF.

Measurements and Statistics

Anthropometric measurements have been weekly taken as soon as possible accurately: the weight has been measured by a conventional scale or a salter hanging scale, and the length by a measuring board placed horizontally on a flat. Weight and length were measured three times consecutively and the average of the three measurements was finally retained.

The measurements were transformed in weight-for-height z-score (WHZ) according the formula: Z-score = (observed value - median value of the reference population) / standard deviation value of reference population. This index was then changed in the equivalent Weight-for-Height percentage (W/H %) of the National Center for Health Statistics (USA) standards. This value was finally used for determining eligibility in the study. A WHZ-score of -4 to – 3 SD (indicative of a severe malnutrition degree) and a WHZ-score of -3 to –2SD (expression of a moderate malnutrition degree) was interpreted as equivalent of 60-70 and 70-80% of W/H percentage respectively (15). Outcomes of the study were computed as WHZ-score increment (Δ value) by subtracting the discharge WHZ-score from the admission WHZ-score. A Δ-WHZ=0 was defined as lack of improvement; Δ-WHZ= > +1 as positive weight improvement; Δ-WHZ= < -1 as treatment failed.

All data were collected by the residents of the post-graduate School of Paediatrics, University of Parma, Italy, during their stay in "G". SPSS for Windows has been used for analyzing. Descriptive data were presented as means ±SD or count and percentages. Homogeneity between patient groups was evaluated with the test of the variance for paired data. Chi-square tests were used to assess statistical differences between percentages. Numerical differences were calculated by Student's t-test. Linear regression was used to establish a hypnotized correlation between WHZ-scores at admission and at the end of the study. Differences were considered significant if $p<0.05$.

The parents of the children enrolled in the study gave a written or verbal consent after being exhaustively informed at the recruitment time thanks the support of local translators too.

Results

Cases and outcome in "G" hospital

Three hundred and thirty-two malnourished children (mean age 14±6.3 months; range 8 to 42 months) were enrolled in the study performed in "G": 177 participants received FSP portions only (Group 1), and 159 participants were treated with FSP regimen plus a supplement of "Parma pap" (Group 2). Demographic characteristics and WHZ-scores distribution at recruitment in both two children Groups are summarized in Table 2. Drop-out rate was 14% (n. 45/332) and it was higher in Group1 (35/45) than in Group 2 (n. 10/45). Missed visits were related to the distance between village and hospital (45%), the lack of public transports (85%) and the inability to entrust to someone the other children left at the village (30%). The death rate was 1%: 2 children from Group 1 and 1

Table 2. A practical scheme for calculating weekly "Parma pap" requirement

Child Weight (Kg)	N. of containers/day (gr)	N. of containers/week	Pap Kg/week
4 – 4.5	1+ ½ (150 gr)	12	1,2
4,6 -5,9	2 (200 gr)	15	1,5
6-7	2+ ½ (250 gr)	18	1,8
7,1-8,5	3 (300 gr)	22	2,2
8,6-9,9	3+ ½ (350)	26	2,6
10,2-11,3	4 (400 gr)	29	2,9
11,4-12,5	4 + ½ (450 gr)	32	3,2
12,6- 14	5 (500 gr)	36	3,6

Table 3. WHZ-score increments (Δ value) in both children Groups computed by subtracting the discharge WHZ-score from the admission WHZ-score

ΔWHZ	Group 1 children (n)	Group 2 children (n)
-3	1	1
-2	5	2
-1	5	3
0	26	12
+1	14	17
+2	31	25
+3	41	37
+4	8	14
+5	15	27

child from Group 2 because of clinical severe conditions at recruitment. No adverse reactions to FSP and/or "Parma pap" administration were observed.

Out of 284 children who completed the study, 229 were recognized as "winners": 109 belonged to Group 1 (74.6%) and 120 to Group 2 (86.9; χ^2 =6.107; p=0.013) (Table 3). The best Δ-WHZ-scores (>+4) were recorded among participants of Group 2 (n. 41; 64%) rather than in Group 1 (n. 36; 21%; χ^2 =4.215; p=0.040). The percentage of children who did not recover was higher in Group 1 (n. 37; 25.3%) than in Group 2 (n. 18; 13%; χ^2 =3.688; p=0.05).

The children receiving FSP portions plus "Parma pap" recovered faster (5.54 week on average) than those treated with FSP regimen only (8.16 on average)

A slight positive correlation has been found between WHZ-scores at admission and at the end of the study (r=0.19; p=0.045).

Cases and Outcome in Makeni

Experience in Makeni concerned only 21 malnourished children 8 to 35 months old, admitted to the infirmary of Xaverian mission with a WHZ-score ranged between -2.8 and -2.2. "Parma pap" was the only supplementary food that they received. Sixteen of these children recovered in 4.9 weeks on average, and five in 6 to 8 weeks. Mean Δ-WHZ-scores ranged between + 1 and + 5. Δ-WHZ-scores of five children who recovered late were between +1 and +2 probably because of more severe clinical conditions at recruitment. Neither side effects nor drop-outs were reported.

Discussion

This study has shown that if "Parma pap" is administered as an additional feeding to FSP regimen it is able to accelerate and improve the nutritional rehabilitation in malnourished children, as we reported in "G". When the same pap is administered as the only food in untreated malnourished children, as it is happened in Makeni Mission, "Parma pap" works like a RUTF (7, 16). In both these cases we can conclude that it is possible to prepare a supplementary feeding in a domestic way starting from local ingredients without resorting to industrial preparations.

When this study was planned we speculated to test "Parma pap" in a randomized study. It was impossible to put this purpose into practice because in the district we operated children at risk of malnutrition were already receiving a FPS regimen. It was ethically not acceptable to stop and substitute a validated feeding program for an optional food whose effectiveness had yet to be tested in the formula that we had chosen.

In this context we forced not to consider "Parma pap" as an alternative food to FSP regimen, but more simply as an additional food to FSP regimen. Increased energy intake "Parma pap"-related resulted in a substantial better growth in Group 2 children. Other solutions were not ethically feasible.

The original project of "Parma pap" was to make an accessible supplementary food prepared from local ingredients that would meet the characteristics of a RUTF and could be successfully used to rehabilitate malnourished children especially those living far from the major distribution centres. This was the case in Makeni. In Xaverian Mission we had the opportunity to give "Parma pap" to malnourished children who were not receiving any supplementary food, and to assay finally the effectiveness of this feeding just as if it was a RUTF. The results were positive as expected.

Both in "G" and in Makeni, our choice about ingredients fell obligatory on peanuts and palm oil being these two foods the cheapest and the most available ingredients at the markets where we operated. This choice centred the strategy of our study. In another Country we could probably make different solutions. According to the available foods at local markets, we could prepare a pap, for instance, with beans, soy beans,

sesame seeds instead of peanuts. The same consideration could be done for the oil: in palm oil place we could use other oils if they had been available, i.e. rapeseed oil or soybean oil, which have moreover the advantage of providing a good balance of essential fatty acids.

The only two pap ingredients that we were forced to find outside were milk powder and multivitamin product: milk was provided by hospital and vitamins powder was imported from US, thanks to the grant which supported this study.

"Parma pap" prepared with local ingredients and with local operators involvement, malnourished children mothers included, allowed us to circumvent at least two of the reported limits of a pre-packed feeding: use of locally unavailable ingredients and passive participation by users.

Same industrially manufactured foods, being extraneous to family customs, are not easily accepted in most local cultures (4, 11). The ingredients of "Parma pap" were on the contrary the same as the mothers were accustomed to seeing in the market. Knowledge of these ingredients has finally convinced them to get involved in the preparation of the pap. This active participation was probably the decisive step to accept that their children were treated with a pap prepared by themselves. This strategy, added to further "Parma pap" advantages (no further preparation before consumption, high energy density, small portions), may have contributed to keep under control the dropout phenomenon among Group 2 children.

The distribution of "Parma pap" daily servings in plastic bags proved to be very practical, in order to avoid oxidation and contamination processes too. We was unable to perform quality control tests for contaminating microbes in this finished product. The indirect evidence that all procedures were properly carried out and that no contamination was reasonably occurred during production could be provided by the observation that no children treated with "Parma pap" had intestinal infections. This result was due also to the use of the palm oil that, like all the oilseeds, prevents bacterial growth and allows to store a locally produced RUTF at ambient temperature for long periods of time (7). During three-years study we did not observe any interference by seasonality on "Parma pap" preparation, administration and acceptability.

Established condition that, for renewing a farther weekly supply, the mothers had to show the empty pap's containers appeared to have been an appropriate solution, and gave us a sufficient guarantee that servings were administered. However we discovered that weekly supplies were sometimes used to feed the whole family too. Expected event.

To transform "Parma pap" into a RUTF totally prepared with local ingredients, we have to find right alternatives to milk powder and multivitamin product. It is not an easy goal because a possible useful ingredient is not always available in all countries where malnutrition occurs. This will be the challenge of the future.

In conclusion, the data from this study suggest that "Parma pap" could be an effective additional food to FPS regimen in malnutrition recovering. Further researches are needed on the contrary to prove if "Parma pap" could be defined as a veritable RUTF, although this characteristic seems already to result from the experience in Makeni Mission.

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