

Adherence to ready-to-use food and acceptability of outpatient nutritional therapy in HIV-infected undernourished Senegalese adolescents: research-based recommendations for routine care.

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Abstract

Background: Ready-to-use food (RUF) is increasingly used for nutritional therapy in HIV-infected individuals. However, practical guidance advising nutrition care to HIV-infected adolescents is lacking, and little is known about the acceptability of such therapy in this vulnerable population. This SNACS study assesses the overall acceptability and perception of a RUF-based therapy and risk factors associated with sub-optimal RUF intake in HIV-infected undernourished adolescents in Senegal.

Methods: Participants aged 5 to 18 with acute malnutrition were enrolled in 12 HIV clinics in Senegal. Participants were provided with imported RUF, according to WHO prescription weight- and age-bands (2009), until recovery or for a maximum of 9-12 months. Malnutrition and recovery were defined according to WHO growth standards. Adherence was assessed fortnightly by self-reported RUF intake over the period. Sub-optimal RUF intake was defined as when consumption of the RUF provision was < 50%. RUF therapy acceptability and perceptions were assessed using a structured questionnaire (week 2) and focus group discussions (end of the study). Factors associated with sub-optimal RUF intake at week 2 were identified using stepwise logistic regression model.

Results: We enrolled 173 participants, with a median age of 12.5 years (Interquartile range: 9.5 – 14.9), of whom 61% recovered from malnutrition within the study period. Median follow-up duration was 66 days (21 – 224). At week 2, sub-optimal RUF intake was observed in 31% of participants. Dislike of the taste of RUF (aOR=5.0, 95% CI: 2.0 – 12.3), HIV non-disclosure (5.1, 1.9 – 13.9) and food insecurity (2.8, 1.1 – 7.2) were the major risk factors associated with sub-optimal RUF intake. Most participants initially reported a positive organoleptic appreciation of RUF. Constraints on RUF feeding were the need to hide from others to avoid sharing and limited time available. Among sub-optimal consumers, disgust and adverse effects attributed to RUF were perceived as barriers impossible to overcome.

Conclusions: This study revealed several factors reducing the acceptability and adherence to RUF therapy based on WHO guidelines in HIV-infected adolescents. Strengthening counselling capacity of HIV clinics, tailoring prescriptions and empowering young patients, are crucial for improving acceptability of RUF-based therapy in routine care.

Introduction

HIV infection can induce growth failure and malnutrition in children, which in turn contribute to faster disease progression. Successful nutritional rehabilitation of young children < 5 years (1), including HIV-infected children (2–4), has been achieved using Plumpy Nut® and Plumpy Sup® (Nutraset, Malaunay, France) food supplements, generically referred to as imported ready-to-use food (RUF). During the last decade, most African countries adopted national guidelines for RUF-based nutritional rehabilitation of children <5 years, including those with HIV. However, malnutrition remains common in HIV-infected adolescents, even when on ART (5, 6), and is strongly associated with morbidity and death (7). Between 2000 and 2015, annual AIDS-related deaths declined for all age groups except adolescents, whose

mortality more than doubled (8). HIV care services for adolescents suffer from multiple deficiencies (9). Despite World Health Organisation (WHO) recommendations for the integration of nutritional interventions into comprehensive HIV treatment programmes (10), inadequate availability of nutritional therapy addressing severe malnutrition at HIV treatment sites in sub-Saharan Africa remains (11). Moreover, the 2009 WHO Preliminary guidelines for an integrated approach to the nutritional care of HIV-infected adolescents (12) remains poorly implemented in African countries. Experimental data and practical guidance advising nutrition care in these vulnerable patients are lacking. A single study recently assessed the effectiveness of Plumpy Nut® on acute and chronic malnutrition in HIV-infected Malian children 1 to 14 years-old (13). However, it did not inform on acceptability and feasibility of nutrition therapy in this context.

While initially developed for paediatric use, RUF provisioning has become a more widely used outpatient strategy among vulnerable adults through food-by-prescription programmes. Qualitative researches conducted in adults enrolled in such programmes in East and Southern Africa and Asia reported that poor palatability of RUF and undesirable effects, including nausea, vomiting, and diarrhoea, induced appetite saturation over time (14–18). Indeed, a primary reason for poor treatment adherence in these studies was disgust and the fatigue of having to consume the product so frequently over a long period.

The effectiveness of medical therapy is strongly associated with its level of acceptance, adherence to prescription, timing of intake, and medical and psychosocial surroundings (19), all of which may differ among patients of different age classes. There is an urgent need for improved approaches to address specific health and nutritional needs in HIV-infected adolescents, which cannot be derived from studies of children or adults. We recently reported pilot data highlighting a mixed reception of RUF use, and high default rate among HIV-infected adolescents living in Dakar, the capital city of Senegal (20). Following this pilot programme, the SNACS Study was implemented to assess the acceptability, effectiveness, and feasibility of RUF-based nutritional therapy among young HIV-patients across Senegal. The intervention protocol followed the 2009 WHO Guidelines (12). The operational objective of this research, conducted in close partnership with the Senegalese Ministry of Health, was to provide the national HIV programme with evidence-based recommendations.

The objectives of the present report are first to describe the overall acceptability of the nutritional intervention including perceptions, behaviours, and constraints surrounding RUF use. Secondly, we assess adherence to RUF prescription and investigate risk factors associated with sub-optimal intake. To our knowledge, the present study is the first to conduct such assessments among HIV-infected undernourished adolescents.

Methods

Study setting

The SNACS study was carried out in Senegal from April 2015 to January 2017 in 12 public paediatric clinics: two in the Dakar district, the capital city, (Albert Royer National Paediatric Hospital and Roi Baudouin Hospital) and 10 in decentralized settings (Regional Hospitals of Saint Louis, Louga, Mbour, Kaoloack, Ziguinchor and Kolda; Health centres of Thiès, Niore du Rip, Bignona and Kolda). Study implementation was gradual, starting with the central sites in April 2015 and ending with the Kolda sites in March 2016.

Study population and procedures

The analyses include participants aged 5 to 18 years under active follow-up for their HIV infection and presenting with moderate acute malnutrition (MAM) or severe acute malnutrition (SAM). MAM was defined as body mass index-for-age z-score (BMIZ) of < -2 and ≥ -3 , and SAM as $BMIZ < -3$ (21). Participants also were without medical complications and succeeded at an appetite test, which assesses their ability to consume a weight-appropriate portion of RUF.

Fortnightly outpatient follow-up visits were conducted by a nurse and a social health worker, under the supervision of a physician, and included clinical assessment, provision of RUF for the next two weeks, and monitoring of adherence to RUF over the preceding two weeks. The participants were monitored until they recovered from wasting ($BMIZ \geq -2$), discontinued the study (default, death), or until the study was concluded, i.e. 9 months in decentralized clinics or 12 months in Dakar. A social health worker counselled participants and caregivers to spread RUF intake throughout the day, to eat the RUF in small bites to cope with nausea and lack of appetite, and to have sufficient drinking water at their disposal to prevent diarrhoea. Participants were also advised to avoid RUF intake during mealtimes, in order to preserve family meals and avoid sharing with other family members.

The study used imported RUF, Plumpy Nut® and Plumpy Sup®. Both are packaged in a 92 g individual sachet providing 500 kcal in the form of an energy-dense lipid paste made from peanut butter, oil, sugar and a high vitamin and mineral supplement (the first contains milk powder, while the second contains soy proteins) (22). Plumpy Sup® is recommended in the management of MAM, amongst other options, while Plumpy Nut® is dedicated to the treatment of SAM. WHO recommends a Plumpy Nut® prescription of 75 to 100 kcal/kg/d in children aged 5 to 10 years and 60 to 90 kcal/kg/d above that age (12). The lowest value was used and maximum energy intake provided by RUF was limited to 2,000 kcal/d i.e. 4 sachets in order to preserve habitual diet and prevent appetite saturation. Across all ages, Plumpy Sup® was prescribed at the lowest recommended dose of 60 kcal/kg/d to participants with MAM.

Data collection and analysis

Participants' characteristics and acceptability assessment. The socioeconomic, clinical, and therapeutic characteristics of the participants were collected at the inclusion visit. The household food insecurity access scale (HFIAS)—a list of nine specific questions about the availability and accessibility of foods

and food-related worries for the household during the previous month—was used to assess food insecurity (23). In this study, we used a binary indicator: food secure vs. food insecure (mild to severe) households. Minimum dietary diversity was defined as having consumed at least 5 food groups out of 10 the day before the study visit, as measured by participant 24-hour recall at enrolment and the first follow-up visit (24). A structured questionnaire covering the organoleptic perception of RUF, mode of intake, constraints affecting intake, and sharing within the household, was administered to participants and caregivers at week 2.

Adherence to RUF prescription. Based on participant/caregiver reports at each visit, adherence indicators were calculated as the percentage of reported RUF sachets consumed out of the number of sachets provided. Early sub-optimal RUF intake was defined when this ratio was < 50% at week 2.

Risk factors of early sub-optimal RUF intake. Associations between early sub-optimal RUF intake with socioeconomic and demographic profiles, RUF acceptability data, as well as ART drug history and severity of malnutrition, were investigated using univariable regression, after controlling for collinearity, as well as stepwise logistic regression models. Explanatory variables with $P < 0.20$ from the univariable analysis were included in the multivariable models and excluded by the stepwise procedure at $P > 0.10$. The final set of variables retained were tested for interactions. Differences were considered statistically significant at $P < 0.05$. Medians are presented with their interquartile range (IQR). All statistical analyses were performed in SAS, version 9.3 (Cary, North Carolina, USA).

Expectations, perceptions and experiences of participants in the nutritional intervention. Following the last visit in the SNACS study, focus group discussions (FGD) were conducted on the Dakar sites with a convenience subsample of participants aged at least 7 years, which aimed to be fairly representative of the study population with regards to sex and severity of malnutrition. Sessions were conducted in *Wolof*, the national language of Senegal, or French, by a social healthworker and the research student (MV) and focused on (i) participant expectations, (ii) perceptions of RUF and (iii) experiences of the nutritional intervention, depending on their outcome in the study (recovery, failure, default). FGD were audio taped and transcribed verbatim into French. The thematic analysis which consisted in coding, synthesizing and grouping sections of text from the FGDs that covered similar issues or experiences, was performed in Dedoose, version 7.0.21 (Los Angeles, California, USA).

Ethics

Ethics clearance for the SNACS study protocol was given by the Ethics and Regulatory Committee and the Ministry of Health in Senegal. All parents or surrogate caregivers provided written informed consent. Participants aged ≥ 7 years received extended information about the research and provided verbal assent (25).

Results

Study population

From April 2015 to September 2016, the SNACS study enrolled 184 HIV-infected participants of whom 173 were between the ages of 5 and 18 years old (median age: 12.5 years, IQR: 9.5–14.9), 104 presenting with MAM and 69 with SAM, were included in these analyses. All but one participant had been infected through mother-to-child transmission. The mother or father was the primary caregiver in 44% and 8% of participants, respectively, while 48% lived with a surrogate caregiver who was an ascendant (grandparents, uncles, aunts: $n = 24$), collateral (siblings, cousins: $n = 57$), or a neighbour ($n = 2$). Eighty-seven percent were on ART at enrolment for a median duration of 48 months (15–75). Only 28% had had their HIV serologic status disclosed with a median time since disclosure of 11 months (5–26). HIV status disclosure was associated with virologic suppression (<50 copies/ml, $P < 0.0001$). Sixty-one percent of participants recovered from wasting after a median follow-up duration of 29 days (16–65), 31% failed to reach $\text{BMIZ} \geq -2$ during the time of the study, 6% defaulted and 2% died. The overall median follow-up duration was 66 days (21–224), which increased from 30 days (16–115) among participants presenting with MAM to 156 days (85–275) in SAM participants ($P < 0.0001$).

Acceptability of RUF and feeding practices at week 2

Overall, 87%, 79%, 85%, and 80% of participants initially rated the RUF aspect, taste, smell, and mouth feeling, respectively, as good. Those who stated they disliked RUF taste perceived it as too salty (38%), too sour (24%), too greasy (24%) or too sweet (14%). Participants who disliked the mouth feeling stated it was too pasty (80%) or sticky (20%). However, up to 30% reported feeling at some point disgusted by RUF (Table 2), and 19% stated there had been occasions when they refused to eat it. At least one episode of diarrhoea and/or vomiting related to RUF intake was reported by 30% of participants at the first follow up visit, 2 weeks after initiating therapy. 24% of participants presented 1 to 3 episodes of diarrhoea and 12% presented 1 to 3 episodes of vomiting. The primary mode for eating RUF was directly from the sachet (85%) (Table 2). Many participants (63%) consumed RUF in place of breakfast, while others reported eating it just before (10%), or just after (12%) meals. Only 15% reported consuming RUF as a snack. At enrolment and at first follow-up visit, 56% and 39% of participants, respectively, reached the minimum dietary diversity the day before the visit. One-third of the participants stated they hid from others when eating RUF (Table 2). The reasons given were fear of envious reactions (42%), arousing pity (19%), or teasing (16%), while 23% chose not to respond to the question. Occasional RUF sharing within the household was reported by 38% of caregivers and participants (Table 2). Caregivers reported that they felt: they (82%), other adults (53%), or other children (67%) in the household needed the RUF.

Adherence to RUF

Most participants < 12 years were provided with 2 to 3 RUF sachets daily while most of their older counterparts received 3 to 4 sachets. If the maximum energy intake to be provided by RUF had not been limited to 2,000 kcal/d i.e. 4 sachets per protocol, 15 participants would have been prescribed 5 to 6

sachets daily. At week 2, participants had consumed 61% of their RUF on average (Table 3). This proportion was stable (varying between 64% and 57%) throughout the follow-up among the remaining participants. Only 11% of participants reported they had consumed all the doses prescribed. Energy intake from RUF was far lower than expected based on the prescription weight bands but was significantly higher in the younger participants per kg of body weight than in their older counterparts (Table 3). In both age groups, there was no difference in proportion of RUF intake and energy intake per kg of body weight according to the severity of malnutrition.

Factors associated with sub-optimal RUF intake

At week 2, 31% of participants were sub-optimal RUF consumers. To identify factors associated with early sub-optimal intake, we ran a stepwise logistic regression model with sub-optimal RUF intake (yes/no) as the dependent variable. Dislike of the taste of RUF (aOR = 5.0, 95% CI: 2.0–12.3), HIV-non disclosure (5.1, 1.9–13.9) and food insecurity (2.8, 1.1–7.2) were the major risk factors associated with early sub-optimal RUF intake (Table 4). There was no association between food insecurity and RUF taste appreciation, however, there was a significant interaction between these two variables in the multivariable model ($p = 0.001$). Stratified analysis indicated that in the absence of food insecurity, proportion of sub-optimal consumers were similar whatever the RUF taste appreciation (Mantel-Haenszel Chi² test probability = 0.36), while in food insecure households, dislike of the taste of RUF was strongly associated with sub-optimal intake ($p < 0.0001$).

Expectations, perceptions and experiences of participants in the nutritional intervention

Qualitative analysis concerned a convenience sub-sample of 24 participants in Dakar of whom 9 were girls and 8 were enrolled as SAM. Two FGD were conducted with participants who recovered within the study (1 group with HIV-disclosed and 1 group with HIV-undisclosed participants) and 2 FGD with those who failed or defaulted using the same format. FGD revealed that all the participants had similar expectations of the therapy. They were very concerned about their physical appearance, associating their skinniness with being short and weak. The SAM participants reported they had been frequently left out of school sports programmes or street football games due to their poor fitness. Participants expressed their strong motivation to gain weight when they started the study. Those who recovered from wasting demonstrated satisfaction and pride in having gained weight. Since youths generally define themselves through the eyes of others, they also perceived the signs of their body shape's normalization in friends' comments: *'People tell me I've got big now! Big as a baobab tree! That I've got stronger and have calf muscles! That I've got more muscle!'* Boy, 9 years, HIV-undisclosed, recovery.

Most participants reported that those around them were not told that they were participating in a nutrition intervention; a strategy often recommended by care workers to avoid RUF sharing. Managing the daily intake of RUF out of sight proved complicated in homes - sometimes polygamous - where there is

practically no space for young people; in particular for boys, to have some privacy: *'I used to hide on the roof terrace to eat (RUF) because I've got a little brother who spends the day asking questions about everything he sees. If I don't give him some he tells his mother and she tells me to give him some.'* Boy, 12 years, HIV-disclosed, recovery. This daily effort by participants and caregivers to conceal consumption of RUF, however, is not always enough to avoid the sometimes necessary intra-familial sharing: *'My grandfather takes some from me, and sometimes he takes a lot. One day 12 sachets went missing.'* Boy, 16 years, HIV-undisclosed, failure, as well as extra-familial sharing, which is sometimes deliberate: *'My friends used to ask me to give them some. I used to steal them from my grandmother's bedroom and I hid them like that (he gestures) and I used to give some outside.'* Boy, 11 years, HIV-disclosed, recovery.

This secrecy, also motivated by the desire to divert friends' curiosity and comments; even from well-meaning adults shows the secrecy that surrounds HIV infection and taking ARV: *'My friends used to ask me what I was taking. I didn't tell them anything. You want to know my secret but I'm not going to say - because I can't say!'* Boy, 14 years, HIV-disclosed, recovery. *'Sometimes I meet people who tell me I've got bigger but I don't tell them anything. I don't want them to ask me.'* Boy, 8 years, HIV-undisclosed, failure.

Close follow-up visits at the hospital affected participants badly, worried that these repeated absences might arouse suspicion at school: *'It used to bother me because I was absent too often. In the end, my classmates used to ask me what I had; sometimes it was my teachers. Only my teaching assistant knew that I was sick. It was my mother who went there. I don't really know what she told them. My classmates used to ask me all the time why I was going to the hospital. I used to change the subject.'* Girl, 16 years, HIV-disclosed, recovery. Repeated absences could sometimes disrupt following classes and learning: *'I lost marks because of my absences. Our lessons are long and catching up classes is complicated. It's difficult to re-copy notes. It makes me tired.'* Boy, 12 years, HIV-disclosed, default.

The main divergence observed between recovery or not in participants concerned perception of RUF and the difficulty to stick to adhere to RUF prescription. Disgust of RUF, sometimes early on, began among the majority of participants over time and was given as the main reason for their failure or abandon: *'We have an illness [HIV-infection] and on top of that we have malnutrition. My friends are well-built; more than me. I feel that I'm malnourished and I am until now. At the start, I wanted it [RUF]. I forced myself; I used to take four (sachets) per day. I even liked it but over time it was the smell. It disgusted me. I couldn't continue any longer.'* Boy, 16 years, HIV-disclosed, default.

Nausea, diarrhoea and vomiting whilst taking RUF was most often reported by unsuccessful participants for whom this represented a huge obstacle: *'The doctor asked me why I wasn't putting on any weight. I told him every time I ate some I felt I was going to vomit. He said 'Oh really?' I replied yes. It was me that decided to give up.'* Girl, 8 years, HIV-undisclosed, failure.

Participants who recovered reported the various strategies they implemented to cope with the growing fatigue they felt in adhering to the RUF prescription, which consisted in alternating between modes of intake, or for some of the oldest, to allow themselves to have breaks of one to two days in RUF feeding. One participant, although affected by the study constraints, reorganized his daily routine around visits to

the clinic and RUF feeding: *'I had to take three and I set the times: at 7:30 am I used to get up and take it. At 12:30 pm I used to leave the room to go into the bedroom. At 7:30 pm I used to go into the bedroom, heat the water, cut [the RUF] in the cup with water. I'd stir it and drink it. I think about my health and growth above all. I've got used to it.'* Boy, 13 years, HIV-disclosed, recovery.

Discussion

Most participants initially reported a positive organoleptic appreciation of RUF. However, many of them needed encouragement from the caregiver for continued RUF feeding, and feelings of disgust were common. On average, participants reported having consumed 61% of their provision, despite the adjustments made to reduce the recommended prescription. The rationale of the WHO prescription weight bands refers to an increase in the recommended nutritional intake levels for asymptomatic and malnourished HIV-infected people, which could reach 50% to 100% of energy needs in children (26). The RUF is thus expected to provide a complete diet to a child with SAM with, in replacement of the habitual household diet, and cover additional energy needs due to HIV-infection (12). Our results suggest that these age- and weight-based prescription bands might have overestimated adolescents' ability to consume RUF in "real life" and that there might be a threshold of RUF intake that some individuals cannot overcome due to nutritional density and sticky composition. Indeed, with the exception of a few studies which proposed 2 sachets daily over short durations, in which HIV-adults stated that they appreciated RUF (27, 28) or adapted to the taste after the first weeks (18), a leading reason for non-adherence was disgust and growing tired of having to consume 3 to 4 sachets per day over a long period of time (14, 15, 17).

At the first follow-up visit, 31% of participants reported having consumed less than half of the RUF provided. Unsurprisingly, disliking the taste of the RUF was associated with sub-optimal RUF intake. This observation is consistent with studies involving HIV-infected adults reporting that many disliked the RUF taste and smell and that RUF taste and consistency made it difficult to swallow (15–18). Food insecurity is known as a major factor of poor adherence to food-by-prescription programmes as individuals are unlikely to refuse food ration sharing. Interestingly, stratified analyses showed that participants disliking RUF were more likely to present sub-optimal intake when they lived in food insecure rather than in food secure households. In case of participant reluctance, caregiver commitment to support RUF feeding might have been lower in the most vulnerable families, which thus encouraged sharing. The absence of association between sharing and sub-optimal intake could suggest that merely occasional sharing, perceived as acceptable, was actually reported. Group discussions with adolescents also suggest that some sharing escaped the attention of the caregivers.

We found HIV-non disclosure to be associated with sub-optimal RUF intake. This finding echoes our recent analysis in the same cohort reporting that HIV-disclosed participants showed a better understanding of the research information at enrolment in the present study (25). Disease disclosure proceeds together with a better understanding of therapeutic issues, such as the importance of adherence

to medication (29). Such empowerment might have similarly benefited the early adherence to the nutritional intervention.

The high prevalence of undesirable effects attributed to RUF in this study is of concern as it might have hindered RUF acceptability and adherence in some participants. Qualitative studies also report similar undesirable effects attributed to RUF in adults on ART or starting ART and pregnant women (14–16). In some of these patients, the initial side effects were transient and attributed to pregnancy or drugs initiation. RUF feeding advice provided by the study staff, although partially followed, are questionable as they may not have been feasible in practice. Many participants used to hide from others when eating RUF, most of the time in the caregiver' bedroom, primarily to avoid being asked to share. Limited time to eat the RUF due to school and transportation, and space constraints in the household combine to hinder the integration of feeding therapy into the usual food practices. In addition, many participants substituted their habitual breakfast with RUF or ate it at mealtime, with possible negative impacts on the dietary diversity provided by family meals. All in all, these constraints on RUF intake contribute to appetite saturation and decreased adherence.

This study has several limitations. First, the validity of information about both adherence and sharing practices is generally difficult to ensure, as some degree of socially desirable response bias might be expected. Counting the RUF sachets would have been a reliable method to confirm participants' reports, but asking them to return with the unused sachets at each follow-up visit seemed not acceptable in our context. Based on our mixed data analyses, we hypothesize that some participants' reluctance to eat the RUF might have resulted in consistent family sharing, rather than regular sharing which would have reduced RUF feeding. Second, attendance at follow-up visits was demanding for these undernourished adolescents, who were at school and who often had long commutes to reach the clinic. However, because of our providing remuneration for travel costs, we documented very few missed or delayed visits. Our results concerning RUF acceptability and adherence might need reassessment considering the constraints of routine care.

Palatability of therapeutic foods constitutes a major constraint for the acceptability of RUF-based nutritional therapy. Further research is needed to offer products with comparable effectiveness and improved organoleptic qualities, particularly for adolescents and adults. Nevertheless, imported RUF are expected to remain by far the most widely used and easily available products for outpatient therapy. It is important to continue to support their use among vulnerable groups in low HIV prevalence countries. Therefore, improving support procedures is crucial when conducting nutritional therapy in the routine care of HIV-infected adolescents.

The socially and physiologically acceptable RUF intake could be assessed with the young patient, and possibly adjusted during therapy according to their progression and tolerance. It would also facilitate increasing the time between follow-up visits to monthly or every other month since adolescents would not be given massive RUF provision.

Compared to other age groups, HIV-infected adolescents exhibit higher rates of loss to follow up (30, 31), poor ART adherence (32, 33), and increased needs for psychosocial support (34). Nutritional rehabilitation is thus an additional challenge to routine HIV care that requires adequate counselling and continuous support to ensure adherence, including preventing or lessening undesirable effects. Particular attention should be paid to adolescents with SAM - who were also older in this cohort- as they are likely to experience longer follow-up duration. This might lead to saturation and discouragement and strongly affect adherence to RUF-based protocols. Staff capacity strengthening, integration of peer and community support and early HIV-disclosure process, could benefit nutritional interventions and improve the acceptability of RUF therapy.

Food-by-prescription is mostly used to focus on HIV-related wasting. Our study did not distribute food for the entire family to complement individual-targeted RUF therapy. Strategies to reduce sharing such as the rationalization of RUF prescription suggested above, the enrolment of other undernourished family members in RUF therapy, together with food complements for the household need to be evaluated.

Conclusion

This study highlights several acceptability issues of RUF therapy based on WHO guidelines in HIV-infected adolescents, which may lead to decreasing adherence to therapy protocols. Beyond the initial barrier of poor appreciation of RUF in some participants, the main factors associated with sub-optimal adherence were closely related to RUF feeding constraints and participants' support and empowerment. Strengthening counselling capacity of HIV clinics, tailoring prescription guidance and empowering young patients in their care, are crucial for improving acceptability of RUF-based therapy in routine care. As such, our findings are valuable in informing improved management of nutritional rehabilitation in this vulnerable population.

List Of Abbreviations

ART	antiretroviral treatment
BMIZ	body mass index z-score (for age and sex)
FGD	focus group discussion
IQR	interquartile range
MAM	moderate acute malnutrition
RUF	ready-to-use food
SAM	severe acute malnutrition

Declarations

Ethics approval and consent to participate

Ethics clearance for the SNACS study protocol was given by the Ethics and Regulatory Committee and the Ministry of Health in Senegal. All parents or surrogate caregivers provided written informed consent. Participants aged ≥ 7 years received extended information about the research and provided verbal assent.

Consent for publication

“Not applicable”

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to French regulations on protection of personal data but are available from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interests.

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Author contributions

CC and FN formulated the research question and designed the study; KD, SMD, AD and MV implemented the study; AD, FND, PBM and SMD collected and monitored the data; CC and MV performed the analyses; CC, MV and FN wrote the first draft of the manuscript. All authors read and commented on drafts and approved the final version of the manuscript.

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References

- 1.WHO. Community-based management of severe acute malnutrition. A Joint Statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children’s Fund. Geneva: World Health Organization; 2007.
- 2.Fergusson P, Chinkhumba J, Grijalva-Eternod C, Banda T, Mkangama C, Tomkins A. Nutritional recovery in HIV-infected and HIV-uninfected children with severe acute malnutrition. *Arch Dis Child*. 2009;94(7):512–6.
- 3.Sadler K, Kerac M, Collins S, Khengere H, Nesbitt A. Improving the management of severe acute malnutrition in an area of high HIV prevalence. *J Trop Pediatr*. 2008;54(6):364–9.
- 4.Sunguya BF, Poudel KC, Mlunde LB, Otsuka K, Yasuoka J, Urassa DP, et al. Ready to Use Therapeutic Foods (RUTF) improves undernutrition among ART-treated, HIV-positive children in Dar es Salaam, Tanzania. *Nutr J*. 2012;11:60.
- 5.Cames C, Pascal L, Diack A, Mbodj H, Ouattara B, Diagne NR, et al. Risk Factors for Growth Retardation in HIV-infected Senegalese Children on Antiretroviral Treatment: The ANRS 12279 MAGGSEN Pediatric Cohort Study. *Pediatr Infect Dis J*. 2017;36(4):e87-e92.
- 6.Jesson J, Masson D, Adonon A, Tran C, Habarugira C, Zio R, et al. Prevalence of malnutrition among HIV-infected children in Central and West-African HIV-care programmes supported by the Growing Up Programme in 2011: a cross-sectional study. *BMC Infect Dis*. 2015;15:216.
- 7.Grinspoon S, Mulligan K. Weight loss and wasting in patients infected with human immunodeficiency virus. *Clin Infect Dis*. 2003;36(Suppl 2):S69–78.
- 8.UNICEF. For Every Child, End AIDS—Seventh Stocktaking Report. New York: United Nations Children’s Fund; 2016.
- 9.WHO. Report of the consultation on the treatment of HIV among adolescents. Geneva: World Health Organization; 2014.
- 10.WHO. Essential prevention and care interventions for adults and adolescents living with HIV in resource-limited settings. Geneva: World Health Organization 2008.
- 11.Anema A, Zhang W, Wu Y, Elul B, Weiser SD, Hogg RS, et al. Availability of nutritional support services in HIV care and treatment sites in sub-Saharan African countries. *Public Health Nutr*. 2012;15(5):938–47.
- 12.WHO. Guidelines for an integrated approach to the nutritional care of HIV-infected children (6 months–14 years). Preliminary version for country introduction. Geneva: World Health Organization; 2009.
- 13.Jesson J, Coulibaly A, Sylla M, N’Diaye C, Dicko F, Masson D, et al. Evaluation of a Nutritional Support Intervention in Malnourished HIV-Infected Children in Bamako, Mali. *J Acquir Immune Defic Syndr*. 2017;76(2):149–57.

14. Ali E, Zachariah R, Shams Z, Manzi M, Akter T, Alders P, et al. Peanut-based ready-to-use therapeutic food: how acceptable and tolerated is it among malnourished pregnant and lactating women in Bangladesh? *Matern Child Nutr.* 2015;11(4):1028–35.
15. Dibari F, Bahwere P, Le Gall I, Guerrero S, Mwaniki D, Seal A. A qualitative investigation of adherence to nutritional therapy in malnourished adult AIDS patients in Kenya. *Public Health Nutr.* 2011;15(2):316–23.
16. Hussein S, Worku A, Aklilu A, Abate K. Ready-to-Use Therapeutic Food for Management of Wasting in HIV Infected Adults: A Qualitative Investigation of Views and Experiences of Patients in Ethiopia. *International Journal of Nutrition and Food Sciences.* 2015;4(5):518–29.
17. Kebede MA, Haidar J. Factors influencing adherence to the food by prescription program among adult HIV positive patients in Addis Ababa, Ethiopia: a facility-based, cross-sectional study. *Infect Dis Poverty.* 2014;3:20.
18. Olsen MF, Tesfaye M, Kaestel P, Friis H, Holm L. Use, perceptions, and acceptability of a ready-to-use supplementary food among adult HIV patients initiating antiretroviral treatment: a qualitative study in Ethiopia. *Patient Prefer Adherence.* 2013;7:481–8.
19. Cavaleri MA, Kalogerogiannis K, McKay MM, Vitale L, Levi E, Jones S, et al. Barriers to HIV care: an exploration of the complexities that influence engagement in and utilization of treatment. *Soc Work Health Care.* 2010;49(10):934–45.
20. Cames C, Varloteaux M, Have NN, Diom AB, Msellati P, Mbaye N, et al. Acceptability of Outpatient Ready-To-Use Food-Based Protocols in HIV-Infected Senegalese Children and Adolescents Within the MAGGSEN Cohort Study. *Food Nutr Bull.* 2016;38(1):27–36.
21. WHO. Guideline: Updates on the management of severe acute malnutrition in infants and children. Geneva: World Health Organization; 2013.
22. Nutriset. Nutritional Solutions' References Malaunay, France: Nutriset; [cited 2015 12/10/2015]. Available from: <http://www.nutriset.fr/en/product-range/scientific-literature/nutritional-solutions-references.html>.
23. Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3).. Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2007.
24. FAO. Introducing the Minimum Dietary Diversity—Women (MDD-W) Global Dietary Diversity Indicator for Women. Roma: Food and Agriculture Organization; 2014.
25. Hejoaka F, Varloteaux M, Desclaux-Sall C, Ndiaye SM, Diop K, Diack A, et al. Improving the informed consent process among HIV-infected undisclosed minors participating in a biomedical research: insights from the multicentre nutritional SNACS study in Senegal. *Trop Med Int Health.* 2019.

- 26.WHO. Nutrient requirements for people living with HIV/AIDS: report of a technical consultation. Geneva: World Health Organization; 2003.
- 27.Beckett AG, Humphries D, Jerome JG, Teng JE, Ulysse P, Ivers LC. Acceptability and use of ready-to-use supplementary food compared to corn-soy blend as a targeted ration in an HIV program in rural Haiti: a qualitative study. *AIDS research and therapy*. 2016;13:11.
- 28.Brown M, Nga TT, Hoang MA, Maalouf-Manasseh Z, Hammond W, Thuc TM, et al. Acceptability of Two Ready-to-Use Therapeutic Foods by HIV-Positive Patients in Vietnam. *Food Nutr Bull*. 2015;36(2):102–10.
- 29.Nichols J, Steinmetz A, Paintsil E. Impact of HIV-Status Disclosure on Adherence to Antiretroviral Therapy Among HIV-Infected Children in Resource-Limited Settings: A Systematic Review. *AIDS and behavior*. 2017;21(1):59–69.
- 30.Auld AF, Agolory SG, Shiraishi RW, Wabwire-Mangen F, Kwesigabo G, Mulenga M, et al. Antiretroviral therapy enrollment characteristics and outcomes among HIV-infected adolescents and young adults compared with older adults—seven African countries, 2004–2013. *MMWR Morb Mortal Wkly Rep*. 2014;63(47):1097–103.
- 31.Lamb MR, Fayorsey R, Nuwagaba-Biribonwoha H, Viola V, Mutabazi V, Alwar T, et al. High attrition before and after ART initiation among youth (15–24 years of age) enrolled in HIV care. *AIDS*. 2014;28(4):559–68.
- 32.Fokam J, Sosso SM, Yagai B, Billong SC, Djubgang Mbadie RE, Kamgaing Simo R, et al. Viral suppression in adults, adolescents and children receiving antiretroviral therapy in Cameroon: adolescents at high risk of virological failure in the era of “test and treat”. *AIDS research and therapy*. 2019;16(1):36.
- 33.Nachega JB, Hislop M, Nguyen H, Dowdy DW, Chaisson RE, Regensberg L, et al. Antiretroviral therapy adherence, virologic and immunologic outcomes in adolescents compared with adults in southern Africa. *J Acquir Immune Defic Syndr*. 2009;51(1):65–71.
- 34.Denison JA, Banda H, Dennis AC, Packer C, Nyambe N, Stalter RM, et al. “The sky is the limit”: adhering to antiretroviral therapy and HIV self-management from the perspectives of adolescents living with HIV and their adult caregivers. *J Int AIDS Soc*. 2015;18:19358.

Tables

Due to technical limitations, Tables 1-4 are only available as a download in the supplemental files section

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