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African stakeholders'views of research options to improve nutritional status in sub-Saharan Africa

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Abbreviated running title: African Stakeholder views of nutrition research

Key words: research policy, stakeholders, under-nutrition, over-nutrition, sub-Saharan Africa

KEY MESSAGES

- Finds that impact, research efficacy and social acceptability are the criteria chosen the most by stakeholders to decide which type of research in nutrition should be prioritized.
- Suggests that research funders should redirect research funds towards developing the evidence base for effective community nutrition interventions.
- Highlights how research funding in behavioural nutrition and investigating the impact of environmental change on nutrition in Africa is also valued, but requires research capacity building through multi-disciplinary collaborations between nutritionists, social scientists, agricultural and climate change scientists.

Ethical review

Ethical approval for the study was granted by the Institutional Review Board of the Institute of Tropical Medicine, Belgium on 8th June 2011 (nr 11 21 3 771) and from Review Boards of partners institutions. All participants provided written informed consent. In case written informed consent could not be provided, verbal consent (through audio-recording) was obtained.

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Conflict of interest

None.

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ABSTRACT

Background

Setting research priorities for improving nutrition in Africa is currently ad hoc and there is a need to shift the status quo in the light of slow progress in reducing malnutrition. This study explored African stakeholders' views on research priorities in the context of environmental and socio-demographic changes that will impact on nutritional status in Africa in the coming years.

Methods

Using Multi-Criteria Mapping, quantitative and qualitative data were gathered from 91 stakeholders representing 6 stakeholder groups (health professionals, food Industry, government, civil society, academics, research funders) in Benin, Mozambique, South Africa, Tanzania, Togo and Uganda. Stakeholders appraised six research options (ecological nutrition, nutritional epidemiology, community nutrition interventions, behavioural nutrition, clinical nutrition and molecular nutrition) for how well they could address malnutrition in Africa.

Results

Impact (28.3%), research efficacy (23.6%) and social acceptability (22.4%) were the criteria chosen the most to evaluate the performance of research options. Research on the effectiveness of community interventions was seen as a priority by stakeholders because they were perceived as likely to have an impact relatively quickly, were inexpensive and cost-effective, involved communities and provided direct evidence of what works. Behavioural nutrition research was also highly appraised. Many stakeholders, particularly academics and government were optimistic about the value of ecological nutrition research (the impact of environmental change on nutritional status). Research funders did not share this enthusiasm. Molecular nutrition was least preferred, considered expensive, slow to have an impact and requiring infrastructure. South Africa ranked clinical and molecular nutrition the highest of all countries.

Conclusion

Research funders should redirect research funds in Africa towards the priorities identified by giving precedence to developing the evidence for effective community nutrition interventions. Expanding research funding in behavioural and ecological nutrition were also valued and require multi-disciplinary collaborations between nutritionists, social scientists, agricultural and climate change scientists.

Introduction

Overall, countries in sub-Saharan African (SSA) show insufficient progress in achieving the first Millennium Development Goal (MDG) to halve the proportion of people who suffer from hunger by 2015, as only 9 of 46 SSA countries are on track (UNSCN 2010-a). Stunting rates are only declining slowly by 0.1% per year, still remaining at 39% for the continent (UNSCN 2010-a). Compounded by a changing ecological and demographic landscape, the trend needs to be dramatically accelerated to reach MDG 1. African countries also show limited evidence of success in reducing the prevalence of underweight (Stevens *et al.* 2012-a) and micronutrient deficiencies (UNSCN 2010-a). For example, the average prevalence of vitamin A deficiency is around 30-40%; iron-deficiency anaemia is fairly static affecting around 40% of non-pregnant African women. In children under five years, even starker estimates are documented, reaching 60% in some African countries (UNSCN 2010-a). Overweight and obesity and related non-communicable diseases are increasingly becoming health problems in SSA (Morris, 2010), especially in urban areas (Stevens *et al.* 2012-b) due to changing dietary habits and sedentary lifestyles (Delpeuch *et al.* 2009). The emergence of Type 2 diabetes and related non-communicable diseases (NCDs) is still likely to be compounded by public health problems of under-nutrition and food insecurity, as well as continued threats of communicable diseases. The public health landscape is likely to become even more complex than it already is, as Africa faces multiple challenges of socio-demographic change, environmental threats from climate change, food scarcity and water shortages, making it crucial that we seek to focus nutrition research effort. When targeted well, research can play a crucial role in improving nutritional status. However, current research efforts in the continent fall short of providing evidence for cost-effective interventions that can prevent malnutrition in all its forms (Lachat *et al.* 2014-b). Given the implications of poor nutrition for individuals and society, there is concern that human capital is not being fostered in Africa and that poor nutritional status is hindering development.

Setting research priorities for nutrition in SSA seems to happen in an *ad hoc* manner, led by donors and funding bodies based in the Global North. Organizations involved in research include both national and international bodies, including universities, research centres, NGOs and Government (Ministries of Health and to a lesser extent Ministries of Agriculture are responsible for nutrition policy in most African countries). Within Africa as a whole, the African Regional Nutritional Strategy for 2005-2015 (African Union 2005) was adopted by African Ministers of Health and Heads of State of the African Union. The strategy recognized that there was a lack of coherence between the importance of nutrition and the low investment in nutrition at all levels (international, regional, national and sub-national). It also highlighted the need for research that would contribute to the evidence base of effective

interventions (WHO 2010). Nutrition researchers from SSA believe that research funding priorities are mainly determined by funding bodies from outside Africa, where SSA governments are relatively minor funders. [9]. The private sector (mainly the agri-food sector) funds some nutrition research in SSA (Van Royen *et al.* 2013), but this is mainly in South Africa.

Systematic approaches to developing national research priorities are rare in SSA (Swingler *et al.* 2005, Rudan *et al.* 2011) and require broad stakeholder involvement and strong links between research and action. There is a need to shift the *status quo* in research activities in the light of the continent's slow progress in reducing under and over-nutrition. Therefore the aim of this study was to explore African stakeholders' views on the research priorities needed in the context of the environmental and socio-demographical changes that will impact on nutritional status in Africa in the next 5-10 years.

Methods

A summary of the different components of the methodology and how they link together is shown in Figure 1.

Using Multi Criteria mapping (MCM)

During in-depth face-to-face interviews, quantitative and qualitative data were gathered using Multi Criteria Mapping (MCM) (Stirling 2006), which is a tool for understanding stakeholders' views to assist in policy development. MCM provides information not only on how different options perform, but why they perform the way they do (Stirling 2006). It has a four-part structure involving: i. *Choosing options:* ways to achieve a policy; ii. *Defining criteria:* the different factors that the interviewee has in mind when assessing research options, e.g. cost, impact; iii. *Scoring options:* numerical measures of how each option performs under different criteria; and iv. *Weighting:* of the relative importance of the criteria in measuring the options. MCM aims to 'open up' assessment by systematically 'mapping' the practical implications of alternative policy options (Stirling 2008).

When stakeholders scored the different policy options they also recorded the reasons for these scores. This process allowed us to understand how the wider context influences their judgments. In this regard, MCM not only maps views on which options are acceptable to stakeholders (content), but also the wider terrain in which these options are to be implemented, i.e.in what context and under which conditions, and which combination of policies is seen as most effective by appraising the relative importance of contextual factors (Stirling, 2006; Holdsworth *et al*. 2012). MCM acknowledges that there is rarely a single 'best' solution to any given policy problem.

Defining research options and stakeholder categories

Six research options (Box 1) considered as relevant to their national contexts were selected by the African researchers in the SUNRAY consortium. Options concerning the broad domains of research in the field of nutrition from the broadest (ecological) through to the most narrow (molecular) level were selected. Full descriptions were given so that interviewees would have a clear understanding of what they were invited to appraise. Interviewees were also able to add additional research options of their choosing, if they wanted to do so. Stakeholders gave their views on the research priorities required to enhance nutritional status in Africa in the next 5 to 10 years.

Sixteen stakeholder categories were identified from six groups with a stake in nutrition research, i.e. civil society, food industry, government, health professionals, researchers/academic and research funders (specific details of these categories are shown in Table 1). These groups were selected as they capture the broad range of stakeholders involved in commissioning, funding, conducting or implementing the findings of nutrition research.

Selecting, scoping and interviewing participants

The aim was to select participants operating at the highest national level to represent their stakeholder group and to reflect a broad 'envelope' of relevant viewpoints. The selection of these individuals was informed primarily by their institutional affiliations. National teams used a snowball approach from key informants to identify key stakeholders. Interviewees were approached by national research teams to explain the purpose of the project, negotiate anonymity and secure consent. The next step was a 'scoping interview' to explain the interview process (Figure 1). Data were gathered from 91 stakeholders: 15 (Benin, Mozambique, South Africa, Tanzania and Togo) and 16 (Uganda). Interviews lasted 2-3hrs and were conducted during 2011-2012. These countries were selected to represent geographical and cultural diversity in SSA and reflect countries at different levels of capacity in nutrition research. Interviews were conducted by senior academics from each country to ensure consistency and access to high level stakeholders through their professional networks. All interviewers underwent a week long training course in Tanzania in March 2011 on the MCM methodology.

Appraising research options and evaluation criteria

During the interview, participants were asked to score each option under different criteria they had chosen, e.g. cost, feasibility. One score was given to reflect performance of an option in the most pessimistic scenario and the second score represented performance under an optimistic scenario, for each criterion. To facilitate interpretation across countries, the criteria that interviewees introduced were clustered into five groups, i.e. cost, impact, research efficacy, practical feasibility and social acceptability (Table 2).

During the interview, MCM software (http://www.multicriteria-mapping.org/mc-mapper) then generated bar charts that indicated the overall relative performance of the options, as perceived by stakeholders, allowing the participant to reflect on the relative performance of the options. Quantitative data were grouped at a national level and for the 6 different stakeholder categories; whereas qualitative data shed light on the factors influencing the performance of different research options.

Data entry and analysis

The analysis of quantitative and qualitative MCM data proceeded in parallel as an iterative, inductive process. The analysis used MCM Analyst software (Stirling 2005) to create a central database for the six countries to be examined individually, or together, as well as by stakeholder groups. In MCM Analyst, the central database was interlinked through Microsoft Access with text reports of the qualitative data and a spreadsheet to process and present quantitative data in the form of charts. Charts show the average of the pessimistic (left-hand end of bar) and optimistic (right-hand end of bar) ranks, i.e. combined weighted scores for all criteria given by all participants.

Results

Criteria influencing decisions

Overall, impact (28.3%), research efficacy (23.6%) and social acceptability (22.4%) were the 3 groups of criteria that were chosen the most to evaluate the performance of research options. Whilst cost (11.2%) and practical feasibility (15.5%) of the different research options were also raised as criteria by some stakeholders, they were used less frequently.

Overall ranking of research options

Figure 2 shows the average of the pessimistic (left-hand end of bar) and optimistic (right-hand end of bar) ranks, i.e. merged weighted scores combined for all criteria given by all participants. Looking at the

mean ranks given by participants under the most optimistic scenarios, the most popular option was research into ***community nutrition interventions***. Qualitative data suggested that research focusing on community nutrition interventions is likely to meet least political resistance, as they are seen as relatively low cost and an efficient use of resources, and likely to be feasible, benefiting from existing expertise and research infrastructure. In addition community nutrition interventions were perceived as likely to be effective in improving nutritional status as well as having social benefits by involving local communities. Some stakeholders highlighted the need to improve data management processes in existing community nutrition interventions, so that their impact could be measured more rigorously.

The next most highly appraised option was research into ***behavioural nutrition,*** which was seen as having the potential to have a high impact if targeted well. Participants noted that the technical expertise in behavioural sciences already existed in Africa for this type of research, especially in South Africa and that this would be a relatively cheap research option. However, concerns were raised that changing individual behaviour is slow and the impact on improving nutritional status is long-term.

Many participants gave good scores under optimistic scenarios for ***ecological nutrition*** research to address the environmental threats that SSA is likely to face in the coming years. Political will for research in ecological nutrition was seen to be high, and it was viewed as useful in providing evidence for interventions and contributing overall to development priorities. However, the reasons the option did not perform better was the lack of existing infrastructure for ecological research- for both technical expertise and material. As a consequence it was seen as expensive, likely to have a slow and low impact. The complexity of this type of research was acknowledged, both in the challenge of designing and conducting rigorous research in the field and the need to use novel multi-disciplinary approaches (including nutrition, agriculture, economics, environmental sciences).

A similar level of support was evident for conducting research into both nutritional epidemiology and clinical nutrition. Participants were unconvinced that ***nutritional epidemiology*** research in its own right would have an impact in reducing the burden of malnutrition, and they expressed much conditionality on its performance, saying that it is most useful for providing evidence for the need for community nutrition interventions. Other concerns were the cost-benefits of this type of research. However, many stakeholders acknowledged its utility in health surveillance and its academic rigor.

The reasons for the relatively poor performance of ***clinical nutrition*** research had a different focus. It was seen as expensive by many and there were doubts that a therapeutic focus was sustainable or cost-effective in the long term at improving nutritional status more broadly beyond the patient group. However, it was also seen as offering established efficacy by many participants, with existing technical

expertise in Africa to conduct this type of research. Research in clinical nutrition was the only option that was ranked higher under pessimistic conditions, suggesting that there was more certainty regarding its performance in different contexts.

The option that performed the worst overall in both optimistic and pessimistic conditions was research in ***molecular nutrition.*** Whilst some stakeholders (particularly those from South Africa) acknowledged its scientific rigor there were many concerns from other countries regarding the lack of existing infrastructure (in terms of laboratory equipment, qualified personnel, electricity supply) to conduct this type of research. Other reservations focused on ethical aspects, particularly regarding genetically modified organisms and a focus on personalized nutrition that was seen as inappropriate or unsustainable for SSA and unlikely to be socially acceptable or have significant impact on a population level.

Ranking of research options- country trends

There was some convergence of views of participants from the six participating countries. Benin, Tanzania, Togo and Uganda ranked the same options in first (community nutrition interventions) and last (molecular nutrition) place. In addition, three of these countries (Benin, Togo and Uganda) ranked clinical nutrition research in 5th place of the 6 options, with relatively high certainty; expressing concerns over its cost and treatment-only focus (Figure 3).

Behavioural nutrition was ranked in second or third place in Tanzania, Uganda, Benin and Mozambique, but its performance in reducing malnutrition was seen less favourably in South Africa, where it was ranked next to last, with high uncertainty about its performance.

South African stakeholders did not follow a similar ranking pattern to the other African countries, for example they ranked molecular nutrition the highest of all countries, putting it in third place. Molecular nutrition was valued for its scientific rigor, the ability to control the data collection process, particularly for external contaminating factors. As for all options in South Africa, there was a high degree of uncertainty of how well they would perform in different contexts (Figure 3). This could be interpreted as a reflection of a context where all types of research are appreciated (as research capacity is relatively high) and are seen as having a complementary role to play in tackling malnutrition in the future. South Africa was the only country to rank clinical nutrition in first place.

There was least agreement between countries for the benefit of research into ecological nutrition on improving malnutrition. Mozambique was the only country to prioritize research into ecological nutrition, and the ecological context of Mozambique was seen as a reason for its consequent

ranking in first place (Figure 3). Stakeholders highlighted recent concerns over climate on the environment (flooding, droughts, cyclones), as well as civil war, shaping their consciousness regarding the importance of the physical environment on nutrition and health.

Ranking of research options by different stakeholder groups

The highest level of agreement between different stakeholder groups was for research on ***community nutrition interventions*** (Figure 4), with all ranking it in first place under optimistic conditions. Only academics ranked it in second place, indicating a considerable degree of conditionality concerning how the option would work in practice under different scenarios.

Behavioural nutrition research had mixed performance from different stakeholder groups, with ranking ranging from second place (by health professionals and research funders), who saw it as having a potentially high impact on nutritional status to 5th place from government, reporting that it takes a long time to change people's behaviour.

Ecological nutrition research was ranked highest by academics and government, who believed that it would be cost-effective in the long term and provide evidence for developing interventions linking nutrition with the environment. However, research funders were more sceptical, ranking research in ecological nutrition in third place. It was unexpected that participants in civil society would be so cautious about this option- they ranked it in 5th place. Reasons behind this included concerns that the nutrition-environment link was not seen as pertinent.

Many participants had mixed views on nutritional epidemiology research and there was a wide variety in scoring, with variability within and between stakeholder groups, with no particular trend emerging. Concerns were expressed that nutritional epidemiology was time consuming if longitudinal studies were needed, and not as high a priority as the other research options. Positive views were held particularly from representatives of the food industry, seeing nutritional epidemiology as providing useful data for interventions and helping to shed light on the causes of malnutrition, therefore representing good value for money.

A wide variety of scores were observed for research into clinical nutrition (see Figure 4), with variability within and between stakeholder groups. However, most participants in the academic sector did not support this option, nor did the food industry. The reasons given were that it was seen as expensive and required a high input of resources. Civil society ranked it highest in second place. Participants who wanted to see research into clinical nutrition prioritised, believed it would have a high impact on nutritional status of malnourished individuals quickly.

There was considerable objection to molecular nutrition research from participants from within all stakeholder groups. Strongly negative views about the performance of this option, even under optimistic conditions, were held by all stakeholder groups, with varying degrees of certainty. Whilst the findings of molecular nutrition research were seen to broadly have value, there was consensus that it was expensive, slow to having an impact and infeasible in most contexts of SSA.

Discussion

The principle aim of this study was to explore African stakeholders' views of what type of research needs to be prioritised for Africa in the years to come, to respond to both under and over-nutrition by mitigating the future ecological and socio-demographic challenges that the continent faces. The study was designed to inform decision making by conducting in-depth interviews with senior stakeholders employed in a broad range of institutions that have some relevance to nutrition in Africa. The findings of this study contributed to the development of a nutrition research agenda that is supported by stakeholders in SSA (Lachat *et al.* 2014).

In order to be useful in policymaking, consultation processes must provide an effective representation of the perspectives of a diverse range of stakeholders, so that their views are accounted for. The findings from this consultation exercise suggest that nutrition research funding for SSA should focus on investing in increasing the evidence base for community nutrition interventions and behavioural nutrition. Despite varying infrastructures and contexts in the countries investigated, there was a great deal of consensus for research in these two priority areas. Stakeholders emphasized the need to focus on evaluating interventions, which is a call for research funders and governments to introduce research policies that target effective solutions, rather than focusing on the treatment of the effects of poor nutrition, which is typically the case in SSA (Lachat *et al.* 2014-b). Others (Leroy *et al.* 2007; Morris *et al.* 2008; Ebrahim *et al.* 2013) have reported that interventions are rarely seen as a research priority by funders, particularly for evaluations of existing interventions (Rudan *et al.* 2007).

There is a shift towards recognising the need to fund the evaluation of interventions by some research funders (e.g. DFID, the European Commission), therefore acknowledging the need for more evidence is needed of what works, reflecting global thinking. For example, the UN General Assembly recommends that one of nine voluntary action plan indicators should be for countries to develop a plan for community based research and evaluation of interventions to prevent NCDs (UN General Assembly 2013). A recent WHO review of nutrition policies globally (WHO, 2013) made a call for more evidence for the effectiveness of interventions in enhancing nutritional status, particularly the double burden of under-nutrition and obesity and related NCDs. The international Scaling Up Nutrition (SUN) initiative reflects a broader shift towards conducting research on solutions rather than causes of malnutrition. The SUN initiative movement currently mobilizes over 42 countries worldwide, with a focus on interventions to prevent under-nutrition, especially in women and children (UN-SCN 2010-b).

Many participants also believed that research on the impact of environmental change on nutrition should also be a priority for funding, but it was seen as more pertinent for some countries in SSA than others, mainly reflecting society awareness of the importance of ecological concerns. It was particularly recognized as pertinent by academics and government, not yet by research funders, which will require greater dialogue between academics and funders about the importance of this emerging area of research. Support for ecological nutrition research indicates that the need to acknowledge societal causes of under and over-nutrition and collaborate with researchers from other disciplines to ensure food security, e.g. in agriculture, environmental sciences, demography, geography, nutrition, economics and sociology, as has been reported by others (Godfray *et al.* 2010). Adopting a whole food system approach to nutrition is also recognised in a recent UN African initiative (UNDP 2012) which identifies food and nutrition security as key to enhancing development in Africa.

It is widely recognized that many policies affecting health are developed and implemented in sectors outside of public health (Brownson *et al.* 2006; Pencheon *et al.* 2006), so research studies to improve nutritional status needs to also acknowledge this. Research prioritisation exercises in Africa on child health (Fontaine *et al.* 2009) also concluded that research should focus on broader societal causes and on providing evidence for cost-effective interventions (Tomlinson *et al.* 2007). To achieve this, the operating environment (Aaron *et al.* 2010; Van Royen *et al.* 2013) needs to evolve to enable these research domains and multidisciplinary approaches to be effectively pursued, so that capacity constraints (Baillie *et al.* 2008; Pelletier *et al.* 2012) are addressed. The top three priorities identified by stakeholders in this study require multi-disciplinary approaches in line with global priorities for nutrition research (Sackler Institute 2013), which has implications for research design and capacity development, including for evidence synthesis, designing and evaluating simple and complex interventions. However, in many SSA countries, nutrition research capacity needs further strengthening (Van Royen *et al.* 2012; WHO 2013) and enhanced internal governance processes (Gillespie *et al*. 2013) so that the translation of research into action can be maximised.

Conducting research in clinical nutrition and in molecular nutrition were viewed as lower priorities, as they were generally seen as expensive and likely to have a lower impact on a large scale. It was only in the South African context that these options were seen as feasible and acceptable, because the research infrastructure and capacity already exists for these types of research.

Much conditionality emerged when stakeholders appraised different research options, indicating that the impact of some research options will depend on the conditions and development context in

which they are applied, including echoing concerns of others (Ebrahim *et al.* 2013) that health literacy [and literacy] will influence the impact of preventive nutrition interventions (Holdsworth *et al.* 2013). The need to engage communities in research activities is key to ensuring research is appropriate in a given context (Tindana *et al.* 2007) and this was illustrated by the importance that the stakeholders interviewed gave to social acceptability of research. The finding that research costs were regarded as less important than whether the research would have an impact, be conducted rigorously and be acceptable to society suggests that even in resource poor settings like SSA, prioritising research that has an impact is crucial, regardless of the financial cost of conducting the research.

The need to target both under- and over nutrition was acknowledged and the growing burden of obesity and non-communicable diseases poses new challenges for research in SSA, where they now contribute one-third of the disability-adjusted life year burden, (Ebrahim *et al.* 2013), but this has not been subsequently matched by research funding (Beaglehole *et al.* 2011). This integration of policy to prevent undernutrition and overnutrition reflects thinking at global level (WHO 2013).

This raises the issue of how research co-ordination can best be achieved, and whether a centralized approach to coordinating nutrition research funding activities in sub-Saharan Africa is required (Lachat *et al.* 2014-a). A multi-sectoral approach may be best accomplished by creating national research bodies with responsibility for nutrition, as national high-level leadership is identified as key if progress is to be made (Beaglehole *et al.* 2011; Pelletier *et al.* 2012). Such an alliance could facilitate a reflection on funding for the research options that have emerged from the SUNRAY project.

It is crucial that research findings are integrated into knowledge transfer processes (Panisset *et al*. 2012) and the findings from this study fed into a consultation exercise with African stakeholders in three regional African deliberative workshops (in East, South and West Africa) as part of the SUNRAY project, therefore feeding into the development of a roadmap for nutrition research in Africa (Lachat 2014-a). These workshops facilitated the exchange of ideas between researchers and funding bodies about research priorities for Africa.

Study limitations

The results discussed in this paper represent the individual points of view of those interviewed. They are presented in a format that is true to the MCM methodology, and are therefore a consequence of this

method, including its constraints. These results cannot therefore be taken as representing the official positions of the organizations in which the individuals interviewed work.

Using MCM for this study is an innovative way of developing policies in nutrition in Africa, where it has been previously used in the development of obesity policy (Holdsworth *et al.* 2012). MCM focuses on 'opening up' the debate (Stirling, 2010), providing governments and research funding bodies with a broad consensus to appropriately respond to the challenge of malnutrition. Other methods, such as the CHNRI (Child Health and Nutrition Research Initiative) methodology (Rudan *et al.* 2010) have successfully been used to set priorities for health research (not specifically for nutrition). Like MCM, they use transparent criteria and weightings to rank options, and acknowledge the context that decisions are made in. One of the strengths of the MCM technique is that it allows participants to select their own preferred criteria for judging the various options. Additionally, MCM allows the uncertainty about outcomes to be addressed during scoring through pessimistic and optimistic scenarios.

It is important to note whether there were significant missing data from any country that might cause a bias in the comparison of countries and in the collated results. Only in Uganda were all categories of participant interviewed– the missing categories in other countries were due to difficulty in obtaining agreement for interviews and/or the only possible representative of this category unable or unwilling to participate. However, the high engagement from stakeholders meant that comparative analysis of the country data was still meaningful. We cannot say that the six case study countries are representative of views in SSA, however, they were selected to include two countries from East, West and Southern Africa, covering various degrees of economic development and nutrition research capacity. The consensus in views (outside of South Africa) suggests that they are a good reflection of the views held within SSA, although research activity in health varies greatly (McKee *et al.* 2012).

Conclusion

This exercise allowed the voice of a range of African stakeholders from different sectors to be heard, which is crucial if calls for nutrition research funding are to address the range of nutritional challenges that Africa faces. Whilst specific research priorities need to be determined at a country level, there was much agreement across SSA for focusing research activity on developing effective community nutrition interventions. Research funders should therefore redirect research funds towards the priorities identified by African stakeholders. This will need to be accompanied by capacity building in evidence synthesis, designing and evaluating simple and complex interventions. Expanding research funding in

behavioural and ecological nutrition were also valued by stakeholders and require multi-disciplinary collaborations between nutritionists, social scientists, agricultural and environmental scientists.

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Box 1. Research options to improve malnutrition

1. Ecological research

Nutrition research in Africa should include ecological approaches to focus on the environmental threats (climate change, food scarcity) that Africa will face and their impact on nutritional status. This will involve conducting integrated research with nutritionists, climate scientists and agricultural researchers to improve the way land is used and our understanding of how communities respond to various exposures.

2. Community nutrition interventions

Nutrition research in Africa should prioritize improving the evidence base for effective interventions to improve the nutritional status of African populations using a participatory approach. This would require the implementation, monitoring and evaluation of nutrition interventions.

3. Nutritional Epidemiology

To investigate *diet-disease relationships,* studies could include: a) research synthesis such as systematic reviews, b) conducting longitudinal studies, c) using secondary data that are available in a country related to nutrition related deaths, hospital admissions and treatment to guide planned interventions.

4. Behavioural nutrition

Nutrition research should give priority to conducting nutrition research that incorporates other disciplines, especially the social, anthropological and behavioural sciences, such as investigating attitudes to address current public health problems.

5. Therapeutic/clinical nutrition

Nutrition research in Africa should focus on improving the ways that nutritional problems are managed. This involves *treating/managing* obesity, undernutrition, micronutrient deficiencies, other nutrition-related diseases and HIV. This may include the use of supplements and human feeding trials.

6. Molecular nutrition (lab based)

Nutrition research in Africa should focus on investing in basic nutrition science using new molecular, genetic and biochemical approaches, such as nutrigenomics so that science in Africa can develop technological approaches to address Africa's nutritional problems.

Table 1. Stakeholder groups

Stakeholder groups (n=6)	**Participant categories (n=16 per country*)**
Health professionals	1. Clinicians-medical research council /public health association 2. Nutritionists via a nutrition society or association
Food Industry	3. Small and medium size agro food industry, e.g. Growers/chamber of commerce/consumer goods council 4. Large scale food industry
Government	5.Ministry of health/nutrition 6. Ministry of Agriculture, food production 7. Ministry of social development/community 8. Ministry of higher education or research
Civil society	9. Public interest non- governmental organisations, health or food group 10. Citizens association /representing public food health and safety
Research/academic	11. Nutrition researcher 12. Agriculture researcher 13. Social sciences researcher
Research funders	14. World bank or similar 15. NEPAD, USAID and others 16. UN agencies, e.g. WHO, UNICEF

*Missing participant categories for Benin(cat. 15); Mozambique (cat. 12); South Africa (cat. 4); Tanzania (cat. 1); Togo (cat. 14)

Table 2. Grouping of participants' criteria into 'issues'

'Issues'	Individual criteria included in the issue category
Impact (on nutrition and society)	Impact on society: reduces poverty and increases equity; empowerment; participation; benefits the environment; food rights. Impact on improving nutritional status; time lag for impact; sustainability; pertinence; reaches the right target groups- especially women and children and minority and vulnerable sub-populations; broad reach of findings in population; findings can be scaled up or applied in reality.
Research efficacy	Quality of research- rigor, representiveness; measurable; originality; multidisciplinary; applied research focus; availability of baseline data; relevance; uses existing evidence; can be evaluated/monitored; publication of results to academic audience; time that research takes to conduct; contribution to new knowledge
Cost	Cost of doing the research; cost-effectiveness; cost of implementing research findings
Practical feasibility	Political and technical feasibility. Policy environment for supporting it. Cooperation of agencies, across departments and sectors; IT infrastructure, equipment, buildings, access to facilities; human capacity available- in terms of skills/ good management structures
Social acceptability	Social, cultural and individual acceptability; popularity; community participation and consultation both before and after research findings are known; culturally relevant; evidence it meets local needs; adapted to reach illiterate populations

Figure 1. Overview of components of Multi-Criteria Mapping (MCM) used in the study

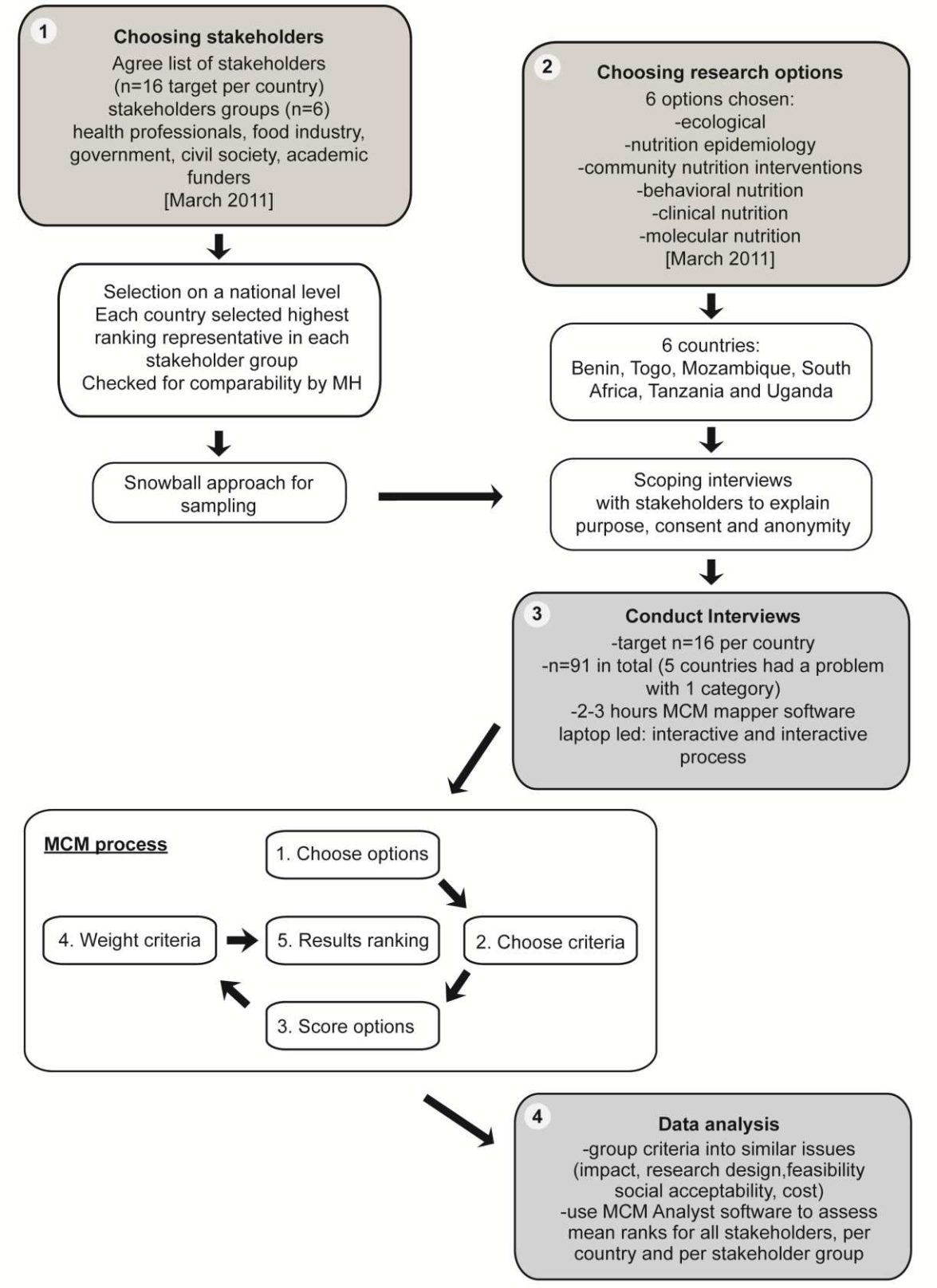

Figure 2. Average ranks for all participants combined.

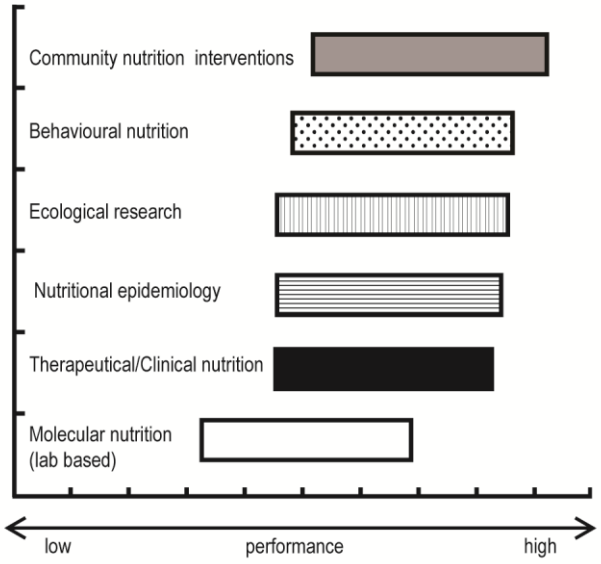

Figure 3. Research option ranks by country.

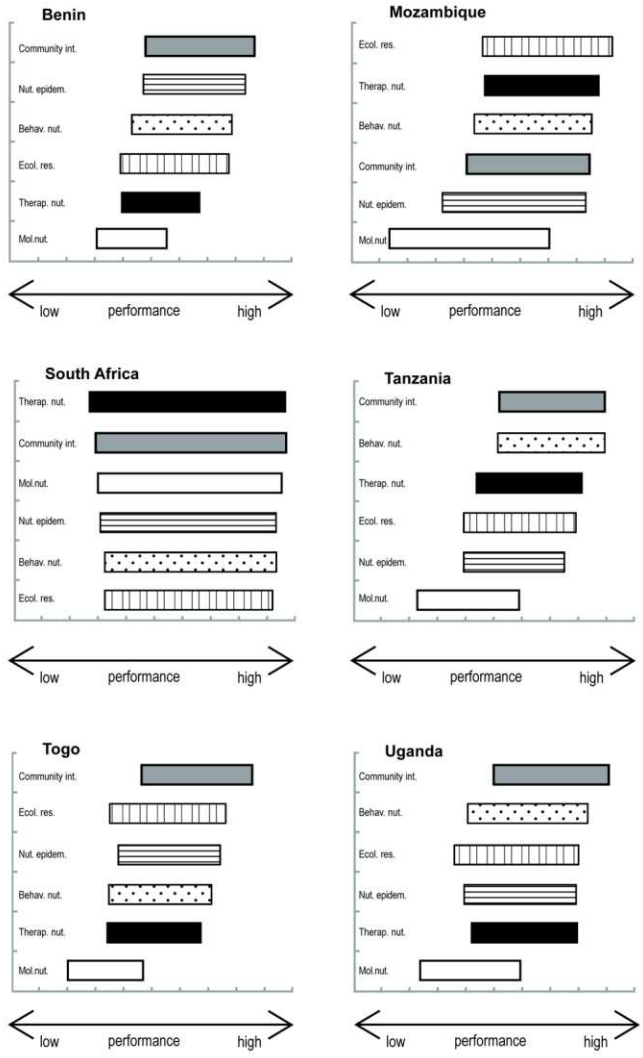

Figure 4. Appraisal of core options by different stakeholder groups.