

Institution: University of Central Lancashire		
Unit of Assessment: UoA3 Allied Health Professions, Dentistry, Nursing and Pharmacy		
Title of case study: <u><i>Tackling the Global Challenge of Hidden Hunger</i></u>		
Period when the underpinning research was undertaken: 2007-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Stephanie Dillon	Principle Lecturer	Feb 08-Present
Fiona Dykes	Professor	Apr 92-Jul 20
Nicola Lowe	Professor	Jun 00-Present
Mick McKeown	Professor	Dec 99-Present
Victoria Moran	Reader	Oct 99-Present
Heather Ohly	Research Fellow	Oct 17-Present
Anna Skinner (Stammers)	Research Assistant	Jun 06-Jun 11
Marisol Warthon-Medina,	Research Assistant	Jan 14-Apr 16
Swarnim Gupta	Postdoctoral Research Assistant	Oct 19-Present
Period when the claimed impact occurred: 2007-2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact (indicative maximum 100 words) Globally, an estimated two billion lives are affected by a chronic deficiency of essential vitamins and minerals, collectively known as hidden hunger, with the greatest burden in low and middle-income countries (LMIC). Lowe's programme of research and engagement has transformed nutrition support for the poorest people in north west Pakistan. It has also generated data that has been used to develop high-zinc wheat that was launched in Pakistan in 2016. Furthermore, it has informed new dietary recommendations in Pakistan, Australia and New Zealand and provided new information for the diagnosis of zinc deficiency. Finally, Lowe's research has directly resulted in the launch of new training programmes in nutrition for researchers addressing malnutrition in Pakistan.		
2. Underpinning research (indicative maximum 500 words) Hidden hunger is a term used to describe inadequate intake of vitamins and minerals that are essential for human health and includes zinc, iron, Iodine and vitamin A. Inadequate zinc intake alone is responsible for 0.8 million deaths a year, with one-third of the global population suffering from a zinc deficiency. Pakistan has a particularly high prevalence of zinc deficiency within the population, which affects 20.6% of children and 40% of women. The consequences are profound and far reaching, at the individual, community and family level, with zinc deficiency resulting in stunted growth, poor cognitive development, poor wound healing and impaired immune function and currently costs the Pakistan government 3% of GDP. Finding a way to improve the nutritional quality of diets for the poorest people is central to meeting the United Nations Sustainable Development Goals (SDGs) particularly SDG2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture. Key to the development of strategies to tackle nutrient deficiencies is a robust evidence-based knowledge of the relationship between nutrient intake, the amount of the nutrient in the body and measurable health outcomes such as growth in children, or cognitive function in adults. With this knowledge in place, accurate estimates of the amount of a given nutrient required in the diet to prevent deficiency can be made and success of interventions designed to improve nutrient intake can be evaluated. Lowe, Moran and Dykes have undertaken a series of systematic reviews and meta-analyses to elucidate the relationships between zinc intake, status and health outcomes as part of an EC Network of Excellence		

from 2007-2012. The systematic reviews led to further publications emerging up to 2018, entitled European Micronutrient Recommendations Aligned (EURRECA). The research generated new data detailing the relationship between dietary zinc intake and status biomarkers, as well as growth in infants and children and cognitive function in adults and children [1-4].

Strategies for improving micronutrient intakes include: supplementation which is the provision of nutrients in the form of tablets or syrups for oral administration; fortification, the addition of nutrients to foods during processing or added to foods at the point of consumption; and biofortification, the enhancement of the nutrient content of staple foods through selective plant breeding and, or addition of nutrient rich fertilizers. All three strategies are complementary and should be used in combination to improve micronutrient intake. Salt fortification with iodine is used globally as a means to increase iodine intake. Lowe and McKeown, alongside Monique Lussier (Northumbria University), conducted an evaluation of a public health campaign to increase awareness and use of iodised salt in a resource poor setting in Pakistan. The research elucidated the communication and pathways of influence between community elders, members and health care providers that led to a significant increase in the knowledge and uptake of iodised salt in a hard to reach, marginalised community [5].

Biofortification has the potential to reduce hidden hunger in the poorest and most marginalised communities worldwide. The nutritional enhancement of staple crops through traditional plant breeding programs provides a sustainable, low cost way to raise the baseline micronutrient intake on a population scale. Lowe, Ohly and Martin Broadley (University of Nottingham), alongside colleagues at Khyber Medical University in Pakistan and the Abaseen Foundation, have undertaken a study of the effectiveness of consuming flour made with biofortified wheat (Zincol2016) on zinc intake and status and the cultural acceptability of this approach among beneficiaries and stakeholders. The research revealed that dietary zinc intake could be increased by up to 50% through consumption of biofortified wheat flour, and that community members and farmers were open and willing to engage with this strategy for improving health [6]. This strategy has the advantage that it can be implemented at population level and does not require individuals to change their eating behaviours.

3. References to the research (indicative maximum of six references)

All references are peer reviewed

1. King JC, Lowe NM, et al. 'Biomarkers of Nutrition for Development (BOND)-Zinc Review. *Journal of Nutrition*. 2016 146: 4 858S-885S DOI: 10.3945/jn.115.220079
2. Lowe NM, Dykes F, Skinner A, Patel S, Warthon-Medina M, Hall-Moran V et al. EURRECA Final Report. Micronutrient Summary: in *Critical Reviews in Food Science and Nutrition*. *Critical Reviews in Food Science and Nutrition* 2013, 53:10, 1110-1123, DOI: 10.1080/10408398.2012.742863
3. Nissensohn M, Lowe NM, Hall Moran V, Skinner AL, Warthon-Medina M, et al. Effect of zinc intake on growth in infants: A meta-analysis. *Critical Reviews in Food Science and Nutrition*. 2016 Feb 17;56(3):350-63. doi: 10.1080/10408398.2013.802661.
4. Warthon-Medina M, Hall Moran V, Stammers AL, Dillon S, Qualter P, Nissensohn M, Serra-Majem L and Lowe NM. Zinc intake, status and indices of cognitive function in adults and children: a systematic review and meta-analysis. *European Journal of Clinical Nutrition* 2015 69, 649–661; doi:10.1038/ejcn.2015.60
5. Lhussier M, Nicola Lowe NM, Westaway, Dykes F, McKeown M, et al. Understanding communication pathways to foster community engagement for health improvement in North West Pakistan. *BMC Public Health* 2016, 16:591- 601; DOI 10.1186/s12889-016-3222-7
6. Mahboob U, Ohly H, Moran V, Lowe NM, et al. Exploring community perceptions in preparation for a randomised controlled trial of biofortified flour in Pakistan. *Pilot and Feasibility Studies* 2020, 6:117 DOI: doi.org/10.1186/s40814-020-00664-4

4. Details of the impact (indicative maximum 750 words)

Lowé is an Associate Director at United Kingdom Research and Innovation (UKRI), a 50% secondment of her role since 2019. She is the Challenge Leader for the Food Systems Portfolio within the Global Challenges Research Fund. Within this role Lowé is a thought leader for global research [A].

Lowé served on the steering group of the International Zinc Nutrition Consultative Group (IZiNCG) from 2015-2018, an internationally renowned group of zinc nutrition experts, whose main focus is to assist and promote efforts to reduce global zinc deficiency, predominantly in low-income countries focusing on the most vulnerable populations. Through publications of research to establish the best practice for the study of zinc and technical briefs, the IZiNCG has become the worldwide 'go-to' guide for the definitive technical information on zinc nutrition research by researchers and policy makers [B].

As a result of the research there has been an impact by providing new data which has been used for the setting of dietary recommendations. Lowé and Moran are currently working with the World Health Organisation to set zinc recommendations for 0-36-month-old children. Furthermore, by providing new data for assessing the effectiveness of dietary interventions to improve zinc intake and by engaging with communities, policy makers, academics, and decision makers there has been a change in knowledge, attitudes and practice around nutrition support in the poorest communities.

Providing new data used for the setting of dietary recommendations

Lowé's research has directly impacted three separate international government policies: the Pakistan Dietary Guidelines for Better Nutrition, 2018 [C], the European Food Safety Authority New Dietary Recommendations for Zinc [D], and the Nutrition Guidelines for Cystic Fibrosis in Australia and New Zealand, 2017 [E].

The Pakistan Dietary Guidelines for Better Nutrition is a government document, produced with support from the Food and Agriculture Organization of the United Nations. They were created using new scientific research and cite Lowé et al. in the context of evidence that the diets in Pakistan are low in micronutrients. Indeed, half of the Pakistani population, 100 million people, is deficient in one or more essential nutrient. This document is a resource for policy makers and multi-sectoral professionals to create appropriate nutritional programmes and policy to improve the nutrition and wellbeing of the population [C].

The European Food Safety Authority recommendations use the research published by the EURECCA Network as the most up to date recommendations for zinc intake worldwide. There is considerable variation in the previously published intake recommendations produced by WHO (2004), Institute of Medicine (2002) and IZiNCG (2004) recommendations. IZiNCG evaluated the European Food Safety Authority recommendations against the previously published values [B]. They identified that one of the major causes of variance in the intake recommendations from the different panels was largely attributed to differences in the proportion of zinc absorbed from their habitual diets. This was governed mainly by their phytate content (a component of dietary fibre), which is a known inhibitor of zinc absorption. Using the most recently published research by Lowé et al, the European Food Safety Authority was able to set dietary zinc requirements for adults at four levels of dietary phytate intake. This is of particular importance for informing dietary interventions in LMIC settings where plant-based diets, high in phytate, are commonly consumed.

These impacts address UN Sustainable Development Goal, specific target 2.2. Which aims by 2030 to end all forms of malnutrition.

Providing new data for assessing the effectiveness of dietary interventions to improve zinc intake

The research described here has impacted the work of the international expert Biomarkers of Nutrition for Development (BOND) programme (2011-2015), funded by the US National Institutes of Health, and the Bill and Melinda Gates Foundation. The aim is to help meet UN

Sustainable Development Goal, specific target 2.1 to end hunger and ensure access, particularly for people in vulnerable situations, to safe, nutritious and sufficient food all year round. BOND have published a comprehensive report that provides a definitive position statement on biomarkers of zinc status for use in human nutrition studies. This report has been used by Australia and New Zealand to develop their cystic fibrosis (CF) guidelines on zinc assessment, dietary guidelines and interventions. Patients with CF are at increased risk of zinc deficiency for numerous reasons including pancreatic insufficiency, malabsorption, chronic inflammation and increased oxidative stress. Up to 40% of children and adolescents with CF are zinc deficient. The recommendations used in the guidelines have been approved by the Australian Chief Executive Officer of the National Health and Medical Research Council [E].

Engaging with communities, policy makers, academics, and decision makers to change attitudes and practice in the poorest communities

Research is currently being conducted by Lowe and Broadley, and colleagues in Pakistan in a programme of research entitled Biofortification with Zinc for Eliminating Deficiency (BiZiFED) [F, G]. The aim of the BiZiFED project is to explore the potential for zinc-rich wheat (Zincol-2016) to increase dietary zinc intake and reduce zinc deficiency on a population scale in Pakistan [L]. Zincol-2016, was developed using traditional plant breeding techniques by HarvestPlus and recently released in Pakistan. Publications from EURECCA and BOND were directly used to set the target grain zinc content during the development of Zincol-2016 by HarvestPlus [H]. According to the Head of Nutrition at HarvestPlus **“Our program had to decide which of the existing dietary intake standards had the most valid scientific base and convened a technical zinc nutrition experts’ consultation at the NIH (Bethesda, MD) that was linked to the BOND project and fortunately included Dr Nicola Lowe. I am convinced that as a result of her authoritative and poised interventions during the consultation and her professional commitment to food-based solutions, the body of experts reached a consensual recommendation that became part of HarvestPlus-Nutrition work plan and resulted in revising up our preliminary zinc requirements by 50-80% and consequently the wheat and rice zinc breeding targets. A few years later, her 2016 Review of Dietary Zinc Recommendations became the basis for our current zinc target calculations. Had that not occurred, our program would have wasted several million dollars in RCTs with nutritionally inadequate (India) wheat and (Bangladesh) rice cultivars.”** [H]

Lowe recently met with the Prime Minister, Imran Khan, to talk about her research to address malnutrition in Pakistan and the biofortification strategy [I].

Central to the research programme in north west Pakistan undertaken by Lowe and her partners, is engagement with communities, local decision makers, stakeholders and academics working together in equitable partnership [J]. This interaction over a period of a decade has influenced knowledge, attitudes and practice around nutrition support for poor communities. It has also influenced education for researchers in this field, resulting in the launch of new Nutrition MSc and MPhil degrees at Khyber Medical University. Furthermore, it has supported nutrition support programs in local hospitals and health centres through our partner NGO, Abaseen Foundation, attracting funding from the Department for International Development (DFID), Wellcome Trust, UKRI/GCRG and the British Council. The project supported by DFID (Poverty Action Fund GPAF-INN-044.) enabled the scale up of services, including nutrition support. During the three-year intervention period (2014-17), a total of 79,358 beneficiaries were provided with peri-natal care and/or nutrition support, including 11,159 women of reproductive age (15 to 49 years) and approximately 11,712 children under five. A total of 98 staff were trained: 22 professional staff (one doctor, two nurses and 19 support staff) and 76 volunteers recruited from the local community (36 outreach workers and 40 traditional birth attendants) [K].

The communities we work with in north west Pakistan are some of the most marginalised in the world. They experience high levels of poverty, bonded labour often involving young

children as part of the workforce, and limited access to basic necessities. Poor quality diets lead to Hidden Hunger and compromised health which exacerbates the cycle of poverty [L]. Rashid Ali Mehdi, Crop Manager on the BiZiFED2 project stated “...our project's backbone is Zincol. Finally, if this research succeeds when we take it into trial on five hundred families and if it were to succeed, its effect will show. So, this will be the government's policy drop and then we will put it in cultural development, mills and all. On one hand, we are working on zinc and stunting and there would have been some learning and awareness. So, this is all part of its benefits.” [L]

These impacts are directly aimed at UN Sustainable Development Goal, specific targets 2.1, 2.2 mentioned above and affect specific target 2.a. This target is to increase the investment in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks. This has the goal of enhancing agricultural productive capacity in developing countries.

5. Sources to corroborate the impact (indicative maximum of 10 references)

- A. Lancet Comment: Helen Lambert, Jaideep Gupte, Helen Fletcher, Laura Hammond, Nicola Lowe, Mark Pelling, Neelam Raina, Tahrat Shahid, Kelsey Shanks (2020) COVID-19 as a global challenge: towards an inclusive and sustainable future. The Lancet, planetary-health Vol 4 e312-e314. DOI: 10.1016/S2542-5196(20)30168-6
- B. International Zinc Nutrition Consultative Group (IZiNCG) website www.izincg.org (Accessed 26th January 2021)
- C. Food and Agriculture Organization of the United Nations and Ministry of Planning Development and Reform, Government of Pakistan. (2018) Pakistan Dietary Guidelines for Better Nutrition. P. 23
- D. Scientific Opinion on Dietary Reference Values for Zinc,' Panel on Dietetic Products, Nutrition and Allergies EFSA Journal, Vol. 12, Issue 10. DOI: 10.2903/j.efsa.2014.3844
- E. Saxby N., Painter C., Kench A., King S., Crowder T., van der Haak N. and the Australian and New Zealand Cystic Fibrosis Nutrition Guideline Authorship Group (2017). *Nutrition Guidelines for Cystic Fibrosis in Australia and New Zealand*, ed. Scott C. Bell, Thoracic Society of Australia and New Zealand, Sydney. <https://www.clinicalguidelines.gov.au/portal/2584/nutrition-guidelines-cystic-fibrosis-australia-and-new-zealand> (Accessed 26th January 2021)
- F. BiZiFED BBSRC webpage <http://qtr.ukri.org/projects?ref=BB%2FP02338X%2F1> (Accessed 26th January 2021)
- G. Article in the Independent: <http://www.independent.co.uk/news/science/biofortification-crops-global-hunger-super-nutritious-science-developing-world-diet-deficiencies-a8183296.html> (Accessed 26th January 2021)
- H. Testimonial letter from Nutrition Unit Head HarvestPlus
- I. Website article on meeting with Pakistani Prime Minister Imran Khan <https://jadarr9.wixsite.com/mysite/copy-2-of-new-ws2020-page-1>
- J. Zaman, M., Afridi, G., Ohly, H. et al. Equitable partnerships in global health research. Nat Food (2020). DOI: 10.1038/s43016-020-00201-
- K. Ohly, Heather, Bingley, Helen, Lowe, Nicola M, Medhi, Rashid, Ul Haq, Zia and Zaman, Mukhtiar (2018) Developing health service delivery in a poor and marginalised community in North West Pakistan. Pakistan Journal of Medical Sciences, 34(3):757-760 DOI: 10.12669/pjms.343.15168
- L. Research Partnerships to address hidden hunger in Pakistan. Project video URL: <https://youtu.be/Z-8O2vVwN9U> (Accessed 26th January 2021)