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in this issue

CHAIR'S ROUND-UP
PAGE 4

EDITORIAL
PAGE 5

ORIGINAL RESEARCH AND REVIEWS
PAGE 9

INNOVATION
PAGE 69

INSIGHTS
PAGE 103

About UNSCN NUTRITION

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Editorial Team: Denise Costa Coitinho Delmuè, Sabrina Ionata de Oliveira Granheim and Stineke Oenema.

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Table of contents

Acronyms **2**

Chair's round-up 4

Editorial **5**

Original research and reviews **9**

- Digital marketing to young people: Consequences for the health and diets of future generations 9
- Using mobile-phone technology to change behaviour: Lessons from mNutrition 25
- Social networking for nutrition: Educational intervention in the digital age 33
- Social-media discussion analysis as a tool for nutrition practitioners 41
- eLearning to empower front-line nutrition workers in India 49
- Digital solutions for nutrition-sensitive SME transformation 57
- Digital marketing of harmful foods to children: A global concern 64

Innovation **69**

- CLICK: The WHO Europe framework to monitor the digital marketing of unhealthy foods to children and adolescents 69
- PLUS School Menus: The future of school menu design 75
- Food salvaging to alleviate hunger and food insecurity: The role of mobile technology 83
- Digital technology to promote inclusion and quality nutrition care for children with disabilities 87
- Using cutting-edge technology to end malnutrition 92
- Improving nutrition and health data to and from remote regions 96

Insights **103**

- Harnessing AI to achieve healthy and sustainable food systems 103
- How digital technology is transforming the food retail landscape 107
- Microbiome research, nutrition and social media: A messaging muddle 116
- Digital solutions to promote nutritious foods: Value chains for biofortified staples 122
- Digital technologies to improve Zimbabwe's food and nutrition security information system 125
- Digital technology to boost agricultural output, improve the food environment and reduce malnutrition in Africa 132
- Digital accountability for the right to food 137

Tribute **141**

Glossary **143**

Acronyms

AI	Artificial intelligence
ATNI	Access to Nutrition Index
AWW	Anganwadi worker (India)
BCPR	Bangladesh cerebral palsy register
BMZ	German Federal Ministry for Economic Cooperation and Development
CGF	Consumer Goods Forum
CHU	Community health units
CHV	Community health volunteers
CLICK	Comprehend the digital ecosystem, Landscape of campaigns, Investigate exposure, Capture on-screen and Knowledge sharing
COPPA	Children's Online Privacy Protection Rule
COVID-19	Novel coronavirus disease 2019 (formerly known as nCov-19)
DataDENT	Data for Decisions to Expand Nutrition Transformation
DLT	Distributed ledger technology
DHS	Demographic and Health Surveys
DNN	Deep neural networks
DWCD	Department of Women and Child Development (India)
FAFH	Food away from home
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FaNS	Food and Nutrition Security, Enhanced Resilience (project)
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
FMI	Food Marketing Institute
FNC	Food and Nutrition Council (Zimbabwe)
FNSIS	Food and nutrition security information system
GAIN	Global Alliance for Improved Nutrition
GeSI	Global e-Sustainability Initiative
GIZ	Gesellschaft für Internationale Zusammenarbeit
GSMA	GSM Association
HFSS	High fat, salt and sugar
HGSF	Home-grown school feeding
IBGE	Brazilian Institute of Geography and Statistics
ICC	International Chamber of Commerce
ICT	Information and communications technology
IDS	Institute of Development Studies
IEC	Information education and communication
IFAD	International Fund for Agricultural Development

IFBA	International Food & Beverage Alliance
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IoT	Internet of Things
ITU	International Telecommunications Union
KFC	Kentucky Fried Chicken
LMICs	Low- and middle-income countries
MDDS	Minimum Dietary Diversity Score
MDD-W	Minimum Dietary Diversity for Women
MIS	Management information system
MUAC	Mid-upper arm circumference
NCD	Non-communicable disease
NLP	Natural language processing
NYU	New York University
OBC	Other Backward Castes (India)
OFD	Online food-delivery
OPM	Oxford Policy Management
PCD	Partnership for Child Development
QR code	Quick Response code
RFID	Radio-frequency identification
RNI	Recommended nutrient intake
SADC	Southern African Development Community
SC	Scheduled Caste (India)
ST	Scheduled Tribe (India)
SD	Standard deviation
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprise
SNAP	Supplemental Nutrition Assistance Program
SUN	Scaling Up Nutrition
UNDESA	United Nations Department of Economic and Social Affairs
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNSCN	United Nations System Standing Committee on Nutrition
USDA	United States Department of Agriculture
USDA ERS	United States Department of Agriculture Economic Research Service
WASH	Water, sanitation and hygiene
WCRF	World Cancer Research Fund
WFA	World Federation of Advertisers
WFP	World Food Programme
WHO	World Health Organization
WWF	World Wildlife Fund

Chair's round-up

AMIR ABDULLA

Interim Chair of UNSCN/UN Nutrition
Deputy Executive Director WFP

Dear UNSCN Nutrition reader,

As Interim Chair of the United Nations System Standing Committee on Nutrition (UNSCN), I am delighted to present our flagship publication for 2020, *UNSCN Nutrition 45: Nutrition in a Digital World.* A wealth of experts, researchers, policymakers and programme implementers have shared their innovations, insights and findings on how digital technologies can be used to promote sustainable healthy diets and improve nutritional status.

When we selected this year's theme just nine months ago, we had not even heard of COVID-19. We are now in the midst of a pandemic. It dominates our thoughts and actions and is driving fundamental decisions on economic and social development.

To slow the spread of the coronavirus, restrictions on movement and physical-distancing measures have been put in place around the world. Digital technology has been invaluable in preserving economic activity and services and ensuring a functioning food supply. *UNSCN Nutrition 45* has proved very timely in advancing the debate on the potential effects of innovative digital technologies on people's nutrition, both positive and negative. It has also informed ongoing discussions at the Food and Agriculture Organizations of the United Nations (FAO) on establishing an International Platform for Digital Food and Agriculture. The ultimate goal of the International Platform is to realize the potential of digitalization to improve the agrifood system by helping governments and other stakeholders to harness the opportunities these technologies present.

As interim Chair of UNSCN, it has been my great privilege to work with our Members to strengthen UN System-wide coherence and coordination arrangements on nutrition. I am happy to inform you that these arrangements have moved on to the next level, with the merger of UNSCN and the UN Network for Scaling Up Nutrition (SUN). This combined, robust entity will be called UN Nutrition. Our flagship publication will continue to address key and emerging nutrition issues under a new name, the UN Nutrition Journal. We are planning to bolster our editorial board and publishing guidelines.

The evolution of UN Nutrition is a tremendous opportunity for global nutrition. It will enable our UN agencies to work even more closely and coherently to assist our Members and the international community in tackling urgent malnutrition challenges in the second half of the Decade of Action on Nutrition, so that we can achieve the Sustainable Development Goals.

We look forward to these new opportunities and will continue to keep you informed. Only together can we overcome the enormous challenges ahead of us and work to improve people's nutrition and well-being, leaving no one behind.

Amir Abdulla
Interim Chair of UNSCN/UN Nutrition
Deputy Executive Director WFP

Editorial

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STINEKE OENEMA

Digital technologies and the internet are causing radical global change. Digital economies are rapidly replacing traditional means of production and trade. Digital technologies are being used throughout the food system (FAO, 2019), influencing the ways in which people interact with it and potentially redefining their food environments.

We chose the theme of *UNSCN Nutrition 45: Nutrition in a Digital World* long before we had even heard of COVID-19. Our call for contributions closed in February 2020 and, in early March, COVID-19 was declared a global pandemic. Digitalization has been playing a key role ever since, enabling vital parts of the world economy to continue functioning, allowing us to remain connected and giving us access to numerous public services, including those directly related to the pandemic.

The disease and the measures taken to curtail its spread have caused severe disruption to day-to-day food supply mechanisms and to food environments. In April, the United Nations System Standing Committee on Nutrition (UNSCN) conducted an online survey to try to capture how people were dealing with these changes (UNSCN, 2020a). It was completed by 2015 people from 118 countries (UNSCN, 2020b) and revealed that almost 75 percent of us had increased our use of digital tools to cope with recent life changes, also when it came to food. Respondents reported more frequent use of grocery delivery apps and websites, for example, as well as food delivery through messaging apps and/or social-media sites. Interestingly, restaurant or takeaway delivery apps did not feature heavily. Rather, recipe apps (15 percent) and recipe websites (36 percent) saw the biggest jumps in usage, confirming findings of a significant rise in home cooking (75 percent) – with a potentially sizeable, positive impact on nutrition.

Overall, however, the increase in the use of food-related digital tools was less significant than we expected. The survey suggested that this might be down to a number of factors. Many viewed food shopping as an opportunity to leave home during quarantine. Others were unable to book food deliveries if they did not belong to a vulnerable or priority group. Elsewhere, there were considerable delays in the delivery of online food orders due to high demand. The survey also showed a desire to support local businesses and producers that might not have had the capacity to 'go digital' – a good example of the growing digital divide. Also, respondents reported high food prices for online deliveries. The last two points illustrate some common risks associated with digitalization.

We had previously featured the topic of digital technology for food and nutrition in *UNSCN Nutrition 44*, which put forward the idea of a digital food environment that "augments the complexity and intensity of the effects of food environments on the health and nutrition status of individuals and populations" (Granheim, 2019: 120). The article suggested that digital technology was affecting

health and nutrition, compounding eating disorders and the prevalence of overweight and obesity and, consequently, fuelling non-communicable diseases (NCDs). Granheim (a guest editor on this edition of *UNSCN Nutrition*) highlighted the need to further explore the growing role of digital technology in shaping (un)healthy food systems.

UNSCN Nutrition 45 builds on this thesis and examines the complexity of the digital world for improved nutrition from a range of food-system perspectives – from food production, transformation and distribution to digital food marketing and retail; from behavioural change and capacity-building, including through social media, to the generation, processing and use of data; and from the protection of vulnerable groups to issues of inequality and human rights.

It is essential to bear in mind that digital technology, in and of itself, cannot fix the world's food and nutrition problems, nor mend its dysfunctional food systems. However, once improving nutrition is deemed a priority, digital technologies are important tools that can help to transform food systems and assist in the design and delivery of food and nutrition measures. Thus, the potential of digital technologies to improve nutrition is considerable, but so are the risks that these technologies might entail, as *UNSCN Nutrition 45* will explore.

In addition to our original research and review articles, *UNSCN Nutrition 45* includes two new categories: innovation articles – which focus on tools and new applied technologies for improving nutrition – and insights – a collection of shorter, original articles that give pause for thought on the nutrition–food–digital technology nexus.

DIGITAL TECHNOLOGIES AND NUTRITION

As COVID-19 has once again indicated, while the benefits of digital technologies are many and compelling, they are accompanied by intrinsic risks and bottlenecks that need to be addressed. The digitalization risks more broadly include increased inequality due to unequal access to digital technologies and digital literacy, cybersecurity breaches and, crucially, ethical and human rights concerns about data privacy and the ownership of health data, biometrics, consumer preference data, behaviour and location tracking, and other personal information.

Another major hurdle is infrastructure. Inadequate physical infrastructure, such as weak internet networks and outdated equipment, and a lack of policy infrastructure, such as regulatory and data-protection frameworks, are widespread, but have a disproportionate effect on low- and middle-income countries. In addition, while digital solutions are evolving, the methods and tools we currently have are not foolproof, for instance, when it comes to bias in data generation and analysis. The limitations of tools such as self-learning algorithms need to be considered as technologies improve.

When it comes to nutrition, in particular, knowledge gaps and varying degrees of digital literacy among beneficiaries, nutrition practitioners and policymakers only serve to deepen the digital divide. Political, regulatory and budgetary support are often lacking, while inadequate infrastructure can damp the potential of digital technologies to improve nutrition and leave no one behind.

Digital channels are increasingly being used to disseminate general, tailored and personalized nutrition messages in an effort to bring about behavioural change. While these channels facilitate greater, faster and cheaper audience reach, widely shared misinformation and disinformation on food and nutrition over the internet is a major concern – and particularly worrying when targeted at children and young people. What's more, digital technology does not replace the emotional support and reassurance of human interaction, which has a pivotal role to play in nutritional counselling.

Information and data are being produced, shared, used and consumed at an ever faster pace. More and more people and services are becoming interconnected around the globe. At the same time, the widening, inequality-fuelled digital divide and the impacts of automation on employment have become major development challenges. The digital world potentially affects not just the underlying and immediate causes of malnutrition in all its forms, but also its root causes and our ability to address them.

It is against this backdrop that the potential of digital technologies to improve nutrition must be analysed. With its rich collection of articles, *UNSCN Nutrition 45* aims to enhance our knowledge and further the debate on the potential benefits and adverse impacts of innovative digital technologies in helping to achieve sustainable healthy diets and progressively realize the right to adequate food.

Most of the articles we present in *UNSCN Nutrition 45* consider this duality. We believe this anthology helps to identify some of the areas where risks appear high and regulation is needed, as well as some where positive impacts can be expected and should be encouraged. Thus, we hope, it can play a role in building a common understanding that can drive joint action and initiatives to improve people's nutrition.

THE WAY FORWARD

Digital processes and technologies are reshaping almost every industry and aspect of human activity. Their potential to accelerate food-system transformation for sustainable healthy diets has not yet been sufficiently investigated, let alone understood. The COVID-19 pandemic has highlighted that we need to invest in a robust digital infrastructure and the widespread digitalization of services, with a particular focus on disadvantaged areas. Digitalization is not only about infrastructure, however. It is also about how we use these technologies and how they change our culture. It is about digital skills. Additional information-gathering and -sharing and further exploratory research are urgently needed to tap into this potential while minimizing the associated risks.

The Food and Agriculture Organization of the United Nations (FAO) is currently in talks to establish the International Platform on Digital Food and Agriculture (FAO, 2020a, 2020b) to advise governments and other stakeholders, fuel an exchange of ideas and experiences, foster innovation and help harness the opportunities presented by digitalization in food and agriculture.

Capitalizing on digital technologies to promote sustainable, healthy diets and improved nutrition needs to be at the core of this and all other debates on digitalization for health, for food and agriculture, and for achieving the Sustainable Development Goals, to ensure that no one is left behind.

We hope you enjoy reading *UNSCN Nutrition 45* and welcome your feedback.

The Editorial Team

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IFAD/ BERNARD KALU

Original research and reviews

Digital marketing to young people: Consequences for the health and diets of future generations

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ABSTRACT

Digital marketing is widely used to promote highly processed food and beverage products with excessive energy and high in fat, sugars and salt (HFSS) to young people, negatively impacting their diet and health. In this paper, we describe the global trends in digital marketing used to promote unhealthy HFSS products to children, adolescents and young adults aged 7 to 24 years. We review the digital privacy policies of 18 major transnational firms – six technology and 12 international food and beverage companies – to promote food and beverage products, brands and healthy and sustainable lifestyles to young people. Our analysis shows that four of the six technology firms have privacy-protection policies for children under 13 years, but that no firm has a digital marketing policy to restrict the targeting of HFSS food and beverage products to young people. Only one of the 12 food and beverage companies studied has publicly pledged not to use digital marketing to promote HFSS food and beverage products to adolescents (aged 13–18). Governments must develop comprehensive privacy-protection laws that restrict firms from using digital marketing to promote HFSS products to young people and only allow products that meet healthy nutrient-profile criteria. Global and national actors should encourage these 18 firms to adopt best practices to use digital marketing to support healthy and sustainable diets, lifestyles and food systems for future generations.

INTRODUCTION

Our globalized food system cannot sustainably promote healthy people and a healthy planet (Swinburn et al., 2019). Companies are using digital technologies to perpetuate unsustainable consumer behaviours that contribute to obesity (Montgomery et al., 2018) and climate change (Swinburn et al., 2019), despite hopes that these technologies would foster social and emotional development, encourage healthy and sustainable choices and mobilize adolescents and young adults to transform their future (Burke-Garcia and Scally, 2014; Patton et al., 2016; UNICEF, 2017).

Global food-system actors have made limited progress on restricting the widespread marketing to young people

of processed, energy-dense and nutrient-poor food and beverage products that are high in fat, sugar and salt (HFSS) and which are linked to poor diet quality, increased obesity, diet-related non-communicable diseases (NCDs) and climate change (Kraak et al., 2016; Kraak et al., 2019; Swinburn et al., 2019). The World Obesity Federation (2019) estimates that 254 million children between the ages of 5 and 19 in 191 countries will be obese by 2030. China (61.9 million), India (27.5 million) and the United States of America (16.9 million) will have the highest obesity burdens (World Obesity Federation, 2019). Poor diet is a leading risk factor in NCD mortality, associated with 11 million deaths and 255 million disability-adjusted life years globally in 2017 (Afshin et al., 2019).

Numerous United Nations and other expert reports have urged state and non-state actors to take comprehensive action to tackle malnutrition in all its forms and create healthy and sustainable food systems that are resilient to climate change (Branca et al., 2020; Hawkes et al., 2020; Swinburn et al., 2019; UNICEF and GAIN, 2018; Willett et al., 2019). These reports have not investigated how digital marketing could be used to achieve these goals, however.

If we are to align the great intergenerational food transformation of the United Nations Decade of Action on Nutrition (2016-2025) with the 2030 Sustainable Development Goals (Swinburn, 2019), young people must have supportive built and virtual environments and the capacity to mobilize resources to advocate for and adopt healthy and sustainable consumption patterns that stay within planetary boundaries (Swinburn et al., 2019).

This paper builds on a *UNSCN Nutrition 44* paper (Granheim, 2019) addressing the under-explored issue of how transnational firms use digital marketing and media technologies to reach young people. We use the term "digital marketing" to refer to any promotional activity delivered through a digital or social-media platform, aimed at individuals, groups and/or populations.

The paper has six objectives. First, we examine the global trends in digital marketing targeted at young people —children (under 12 years), adolescents (12–18 years) and young adults (19–25 years). Second, we explore the child- and adolescent-focused privacy and marketing policies of six transnational technology firms that own popular social-media platforms. Third, we review the policies of 12 International Food & Beverage Alliance (IFBA) firms on the marketing of food and non-alcoholic beverage products, brands and healthy and sustainable lifestyles to young people. Fourth, we examine evidence from 16 studies (2014–2020) on how 18 transnational firms have used digital marketing and social-media platforms to engage young people with food and beverage products and brands. Fifth, we compare these policies with best-practice recommendations to reduce children's exposure to digital marketing. Sixth, we suggest policies and actions for global and national actors, including United Nations agencies and Member States, technology and food and beverage firms, and civil-society organizations (CSOs), to ensure that digital marketing and media are used to foster healthy and sustainable diets, lifestyles and food systems for future generations.

GLOBAL TRENDS IN DIGITAL MARKETING TARGETED AT YOUNG PEOPLE

The 2019 Global Digital Report estimates that nearly half (3.5 billion) of the world's population currently uses social-media platforms (We are Social, 2019). Children and adolescents are rapid adopters and frequent consumers of digital marketing communications and social media (Patterson et al., 2016). Children and adolescents of the current generation are digital natives, raised in digital media-immersed environments, exposed to computers, videogames and social-media applications (apps) from an early age, which influences how they think and process information (Dingli and Seychell, 2015).

The United Nations Children's Fund (UNICEF) (2018a) describes digital technologies as "revolutionizing marketing strategies to broaden their influence" and reach people in more than 200 countries (Figure 1). The State of the World's Children 2017 report focused on young people aged 15 to 24 years in the digital world (UNICEF, 2017). At 71 percent, this is the most internet-connected age group, compared with just under half (48 percent) of the total world population. Yet, about 29 percent of young people (346 million youths), notably in Africa, are disadvantaged by the digital divide, with limited access to the internet or online digital technologies, unlike their counterparts in the more affluent countries of Europe, the Americas and Oceania (UNICEF, 2017).

Figure 1.

HOW DIGITAL MEDIA ARE USED TO TARGET AND INFLUENCE YOUNG PEOPLE

Source: *UNICEF (2018)*

Digital marketing is part of a broader set of integrated marketing communication strategies used by transnational food, beverage, restaurant and entertainment firms to promote brands and products to children (aged 2–11 years), Generation Z teens (12–19 years), Millennials (20–34 years) and older adults (Generation X, Generation Y, Baby Boomers and the Silent Generation) (Kraak et al., 2016; Nielsen, 2015). In 2018, the International Chamber of Commerce (ICC) expanded the definition of marketing communications it applies to children and adolescents up to the age of 17 to include advertising and promotion, sponsorships, direct marketing and digital marketing communications intended to influence consumer behaviour (ICC, 2018).

Young people are especially vulnerable to the interactive nature of the advertising and marketing of energy-dense and nutrient-poor HFSS food and beverage products promoted through digital media platforms (Boyland et al., 2020; Kelly et al., 2015; Montgomery et al., 2012). These platforms include mobile devices, online and subscription videos on demand, interactive games with embedded brands and product placement, social-media and content-sharing platforms and social-networking websites that influence peer interactions, diet and health outcomes (Boyland et al., 2020; Kelly et al., 2015; Montgomery et al., 2012).

Studies in European countries have shown that children aged 7 to 15 years are using digital media more frequently and that the websites they visit most often are not child-specific, but platforms that offer a range of content for different ages (WHO Europe, 2016). Younger children (aged 9–12) tend to view videos through YouTube, while older children (aged 13–16) use social-networking sites. Children aged 13–17 spend most of their screen time on social media (WHO Europe, 2016).

In a recent study by the Pew Research Center, 95 percent of 13–17 year-old American adolescents surveyed said they had access to a smartphone. Forty-five percent reported being online "constantly" and using YouTube, Instagram and Snapchat as their favourite social-media platforms (Pew Research Center, 2018). Adolescents have been shown to be more likely to share social-media posts for unhealthy food products with their peers, to recall and recognize more brands associated with unhealthy food products, and to view advertising for longer when interacting with their peers, celebrities or companies (Murphy et al., 2020).

THE CHILD- AND ADOLESCENT-FOCUSED PRIVACY AND MARKETING POLICIES OF TECHNOLOGY FIRMS

Six transnational digital technology firms dominate the industry and are among the wealthiest public companies in the world, with collective annual revenue of more than USD 548 billion in 2019 (Forbes Media, 2020). They are Alphabet (USD 137 billion), owner of Android Enterprise, Google and YouTube, each of which operate in 40–90 countries worldwide; Amazon Global (USD 233 billion), which owns Twitch Prime and operates in more than 100 countries globally; Facebook (USD 55.8 billion), which also owns Instagram, Messenger, WhatsApp and Oculus and operates in more than 190 countries worldwide; Microsoft Corp. (USD 118.2 billion), present in 210 countries worldwide; Snap, Inc. (USD 1.2 billion), which owns Snapchat and operates in 15 countries; and Twitter (USD 3 billion), which operates in more than 200 countries (Forbes Media, 2020).

In January 2020, we searched each firm's website for specific policies on privacy protection and the use of digital marketing and media to promote food and beverage products and brands to young people. Google and Google's YouTube Kids, Facebook, Snap and Twitter provide detailed policies on their public websites to protect children's privacy and restrict digital content that would endanger the emotional or physical well-being of minors under 13 years. Amazon Global and Microsoft did not have a child privacy-protection policy on their websites.[1]

Google's policies for YouTube and YouTube Kids, the world's largest video-sharing websites, were revised in 2019 after complaints by CSOs concerned about branded advertisements and sponsored commercial content by influencers targeting children through the YouTube and YouTube Kids' platforms (Center for Digital Democracy, 2016).

Social-media influencers can have thousands or millions of followers online and they monetize this through sponsored content aimed at shaping young people's lifestyle choices and behaviours (De Veirman et al., 2019).

The US Federal Trade Commission required YouTube to pay a USD 170 million penalty for not obtaining parental consent when collecting data on children under the age of 13, violating national and state privacy laws for children (US Federal Trade Commission, 2019). Since January 2020, YouTube has informed advertisers that it limits personal data from children under 13 to comply with the Children's Online Protection Privacy Protection Rule (COPPA) (US FTC, 2019).

In 2019, Facebook and Instagram updated their advertising policies and applied age restrictions, prohibiting content that promotes diet, weight loss or other health-related products for young people under the age of 18 (Facebook, 2020b; Roesler, 2019). This policy could be adopted by other technology firms and expanded to cover branded food and beverage products and websites that target adolescents and young adults in all countries where these firms operate. We found no public commitments by these firms to use digital marketing to children and adolescents (up to 18 years) solely to encourage healthy food and beverage products and brands.

1 Please see Google (2020), YouTube Kids (2020, Facebook (2020a), Snap (2020), Twitter (2020), Amazon Global (2020) and Microsoft (2020).

THE DIGITAL MARKETING POLICIES OF TRANSNATIONAL FOOD AND BEVERAGE FIRMS

IFBA represents the world's 12 largest transnational food and beverage manufacturers, present in up to 200 countries (Table 2), with collective annual revenue exceeding USD 369 billion (IFBA, 2020a; Kraak et al., 2019). In 2009, IFBA firms adopted a Global Policy on Marketing Communications to Children (IFBA, 2020b) and, in 2018, they published a 10-year progress report on responsible marketing to children (IFBA, 2018).

An evaluation of IFBA's Global Marketing Communications Policy (2009-2019), however, showed several weaknesses that failed to protect children under 18 years from the aggressive marketing of unhealthy HFSS foods and beverages (Kraak et al., 2019). Areas to be remedied included: (1) failure to use a children's rights-based approach, as recommended by the United Nations (UNICEF, 2018a); (2) failure to cover the wide range of digital marketing and media in voluntary pledges for children under 12; (3) failure to extend pledges to protect children aged 12-17, as recommended by the ICC (2018) or children up to 18 years, as recommended by the World Health Organization (WHO) (2016) and UNICEF (2018a); and (4) failure to adopt uniform nutrient-profiling standards to guide all marketing practices for food and beverage products and brands targeted at young people (Kraak et al., 2019). The assessment issued six recommendations to strengthen IFBA's Global Policy to protect children worldwide from HFSS food and beverage marketing practices.

We examined IFBA's current Global Policy (IFBA, 2020b) and the 12 IFBA members' marketing policies between 15 December 2019 and 20 January 2020 to assess whether they addressed the digital marketing of healthy food and beverage products and healthy and sustainable lifestyles to children and adolescents up to 18 years of age. Most IFBA firms have included certain digital marketing and media policies that apply to children under the age of 12 years. Mars, Inc. reports that it has aligned its online marketing communications and digital media with the amended COPPA law (US Federal Trade Commission, 2013) and the European General Data Protection Regulation by not marketing to children aged 13 years or younger (Mars, Inc., 2018). General Mills has said it will not promote food and beverage products that use digital or interactive marketing (websites, blogs and games) to children younger than 12 years of age and is the only firm to extend its voluntary commitment to cover digital marketing communications to adolescents aged 12 to 18 years (General Mills, 2019).

In 2017, Ferrero reported that it had applied ICC's framework for responsible food and beverage communications (Ferrero, 2017). The ICC updated its policy in 2018 to recommend that businesses expand their voluntary commitments to children and adolescents up to the age of 17 and apply this to the full array of digital marketing communications (ICC, 2018). At the time of writing, Ferrero had not updated its policy to reflect the ICC age limit.

The Coca-Cola Company and PepsiCo have not updated their policies on responsible marketing to children for five years now, according to their websites (Coca-Cola, 2015; PepsiCo, 2014). Danone, Kellogg Company, Nestlé and Mondelez International have pledged to cover select digital media and marketing practices that apply only to children under 12 years (Danone, 2019; Kellogg Company, 2018; Nestlé, 2018; Mondelez International, 2018a). Unilever updated its advertising and marketing principles and policies in February 2020 to apply to all marketing communications on digital and social-media platforms to children under 13 years (Unilever, 2020a).

Grupo Bimbo and McDonald's Corporation did not post specific policies on food and beverage marketing to children on their public websites (Grupo Bimbo, 2020; McDonald's, 2018; Alliance for a Healthier Generation, 2018; Kraak et al., 2019). Grupo Bimbo's 2019 annual report, however, stated that the firm had embarked on new commitments in relation to advertising and marketing to children in line with WHO recommendations (Grupo Bimbo, 2019).

Several IFBA firms or their corporate foundations currently fund or partner with communities and non-governmental organizations to implement healthy or sustainable lifestyle programmes to encourage both healthy and responsible consumption behaviours by children worldwide (Drewnowski et al., 2018; Newson et al., 2013; Robinson et al., 2014). Examples include Danone's One Planet, One Health initiative (Danone, 2017); Nestlé's Start Healthy Stay Healthy Programme and Healthier Kids Programme, which aim to reach 50 million children aged 3–12 by 2030 (Nestlé, 2020); Unilever's Sustainable Living Plan (Unilever, 2020b); and Mondelez International's Healthy Lifestyles Program (Mondelez International, 2018b).

We found no independent assessments of how IFBA firms are using digital marketing to promote healthy and sustainable lifestyle programmes to young people globally, given their current practices promoting HFSS products. This is important, as IFBA firm Nestlé plans to commercialize a "wellness ambassador" to promote a personal nutrition approach based on digital technologies (such as wearable devices, artificial intelligence, dietary intake, fitness assessments and energy sensors) to influence young consumers' dietary behaviour and health (Adams et al., 2020; CB Insights, 2019). There is a need for universal measures of the effectiveness and unintended consequences of such programmes at a national, regional and global level.

EVIDENCE OF DIGITAL MARKETING USED TO PROMOTE BRANDS AND PRODUCTS TO YOUNG PEOPLE

Montgomery et al. (2011; 2012; 2017) have described six digital marketing features that companies use to target young people: (1) immersive environments, (2) engagement that fosters emotional connections between young consumers and brands, (3) user-generated content, (4) personalization through "big data" infrastructure that involves the online tracking of behavioural data, (5) social-networking websites and (6) ubiquitous connectivity. These activities are also referred to as "surveillance capitalism"— a strategy used by powerful corporations to predict and control people's behaviour (Zuboff, 2019). Technology, food and beverage manufacturers use biometric information, geolocation technologies and mobile marketing techniques, promoted through physical and virtual online retail settings, to develop personalized, targeted marketing that can predict and influence the "path-to-purchase" e-commerce behaviour of customers (Montgomery et al., 2017; Seklir et al., 2016).

Systematic reviews and a meta-analysis have shown food and beverage firms using digital advergames and videos to reach children and adolescents. Their engagement can range from 2 to 12 minutes per interaction and the digital marketing strategies involved strongly influence their choice and consumption of unhealthy food and beverage products (De Veirman et al., 2019; Folkvord and van 't Riet, 2018; Qutteina et al., 2019a; Smith et al., 2019).

We conducted a rapid scoping review of research published between 2014 and 2020 and identified 16 studies through the PubMed electronic database. We included publications if they explored digital marketing and social-media platforms and strategies used to reach children, adolescents and young adults. The studies we included were conducted in nine countries, involving young people aged 7 to 24

years. Nine of the studies mentioned one or more of the 18 technology, food, beverage or restaurant firms discussed in this paper.

Figures 2A and 2B illustrate the global nature of this research and emphasize findings relevant to the corporate brands and digital marketing practices of specific firms. The countries where studies have been conducted were Australia (Boelsen-Robinson et al., 2015; Buchanan et al., 2017; 2018; Freeman et al., 2014; Vassallo et al., 2018), Belgium (Qutteina et al., 2019b), Canada (Potvin-Kent et al., 2019), Malaysia (Tan et al., 2018), New Zealand (Vandevijvere et al., 2017), Thailand (Jaichuen et al., 2019), the United Kingdom (Coates et al., 2019) and the United States of America (Bragg et al., 2019a; 2019b; Fleming-Milici and Harris, 2020; Polacsek et al., 2019), as well as a multi-country study that examined associations between digital and traditional marketing and sugared-beverage exposure and consumption among adolescents and young adults in Australia, Canada, Mexico, the United Kingdom and United States (Forde et al., 2019).

Nine studies from four countries (Australia, Canada, Thailand and the United States) examined the marketing practices of transnational technology and/or IFBA food and beverage firms to promote brands or products to young people. Figures 2A and 2B show the media followers, posts and social-media accounts of young people frequently exposed to HFSS snack and sugary-beverage brands owned and marketed by IFBA members, including The Coca-Cola Company, PepsiCo and energy-drink manufacturers Red Bull and Monster (Bragg et al., 2019b; Freeman et al., 2014). The studies showed that digital marketing was used by nine IFBA firms to encourage young people to buy, share, promote and consume energy-dense, nutrient-poor HFSS food and beverage products through company-owned and third-party websites and social-media platforms owned by transnational technology firms, shared as Instagram and Facebook posts, Twitter tweets and YouTube videos (Boelsen-Robinson et al., 2015; Bragg et al., 2019a; 2019b; Buchanan et al., 2017; Fleming-Milici and Harris, 2020; Freeman et al., 2014; Jaichuen et al., 2019; Potvin-Kent et al., 2019; Vassallo et al., 2018).

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Figures 2A and 2B. NINE DIGITAL MARKETING STUDIES THAT EXAMINE PRODUCTS AND BRANDS PROMOTED BY FOOD AND BEVERAGE FIRMS* THROUGH SOCIAL-MEDIA PLATFORMS, 2014–2020

	Study	Target audience	Digital platform	Company	Key results
Australia	Boelsen-Robinson, 2015	Children and adolescents <12 to 17 years	Facebook, brand websites and mobile phone apps	**McDonald's Corporation** Cadbury **The Coca-Cola Company**	85% of promotional activities used four or more marketing strategies; 81% promoted unhealthy dietary behaviour
Australia	Buchanan, 2017	Young adults 18–24 years	Brand websites and social-media sites	Red Bull GmbH Frucor	Digital marketing of energy drinks increases purchase and consumption intention
Australia	Freeman, 2014	Not applicable	Facebook	7-Eleven, Cadbury, Doctor's Associates Inc, Domino's, **Ferrero International**, Franchised Food Company Pty Ltd, Frucor, **Kellogg Company**, **Mars Incorporated**, **McDonald's Corporation**, **Mondelez International**, Monster Worldwide Inc, Red Bull GmbH, Restaurant Brands International, **The Coca-Cola Company**, **Unilever**, Yum! Brands	All food and beverage brand pages in the final sample were classified as energy dense, nutrient poor (EDNP); common techniques were competitions based on user-generated content, interactive games and apps
Australia	Vassallo, 2018	Not applicable	Instagram	Domino's, **Ferrero International**, **McDonald's Corporation**, **Mondelez International**, Monster Worldwide Inc, **PepsiCo**, Red Bull GmbH, Restaurant Brands International, Starbucks, Subway, **The Coca-Cola Company**, **Unilever**, Yum! Brands	Each brand used 6–11 different marketing strategies in their Instagram accounts; EDNP foods and beverages are flourishing
Canada	Potvin-Kent, 2019	Children and adolescents 7–16 years	Facebook, Instagram, Snapchat, Twitter and YouTube	**McDonald's Corporation**, Starbucks **PepsiCo**, **Mars International**, **The Coca-Cola Company**, Restaurant Brands International, **General Mills Inc**	72% exposed to food marketing, most promoted unhealthy products; children and adolescents see food marketing 30 and 189 times, respectively, on average per week on social-media apps

	Study	Target audience	Digital platform	Company	Key results
Thailand	Jaichuen, 2019	Children, adolescents and young adults 6–14 years and 15–24 years	Facebook	AJE, Ezaki Glico Co., Ltd, Fraser and Neave Limited Hot Pot Buffet, Ichitan Company, International Dairy Queen, Inc, **McDonald's Corporation**, **Nestle**, Ogilvy Group, Oishi Group, **PepsiCo**, Restaurant Brands International Inc, Sermsuk Public Company Limited, Sizzler, Starbucks, Swensen's **The Coca-Cola Company**, TCP Group, Thai Best Snack Co., Ltd, The Pizza Company, **Unilever**, Yum! Brands	Food-brand Facebook pages in Thailand do not comply with government regulations and the industry's self-regulatory codes; the most common marketing technique was the use of pictures
USA	Bragg, 2019a	Adolescents 12–17 years	Television, website, radio station, newspaper, and magazine	**PepsiCo**, Wrigley Company, Post Foods **Ferrara International**	Participants liked 84% of the ads; 90% had a positive, effective reaction; 64% "liked" or "followed"; no significant difference between race/ethnicity
USA	Bragg, 2019b	Adolescents 12–17 years	Instagram, Facebook, Twitter Tumblr, Vine	**The Coca-Cola Company**, **McDonald's Corporation**, Starbucks, Red Bull GmbH, Yum! Brands, **PepsiCo**, Hansen Natural Corp, Doctor's Associates Inc, Dr Pepper Snapple Group, International Dairy Queen, Restaurant Brands International, Dave Thomas, Chick-fil-A	Social-media accounts increased 567% from 2007 to 2016; 31.5% (n=630) had an interactive feature; 67.9% (n=362) of foods were unhealthy
USA	Fleming-Milici, 2020	Adolescents 13–17 years	Computer, tablet or smartphone use, including texting, watching movies/TV and social media	**McDonald's Corporation**, Yum! Brands, Wendy's Company, Restaurant Brands International, Applebee's International, Domino's Pizza, Chick-fil-A, Doctor's Associates Inc, **The Coca-Cola Company**, **PepsiCo**, Dr Pepper Snapple Group, The Hershey Company, **Mars Incorporated**, **Nestle**, **Mondelez International**	70% of adolescents engaged with food and beverage brands on social media; 50% engaged with unhealthy food and beverage products

* IFBA firms are in bold

BEST-PRACTICE RECOMMENDATIONS TO REDUCE CHILDREN'S EXPOSURE TO DIGITAL MARKETING

Digital technologies have heightened public policy debate on the roles and responsibilities of parents, communities, governments, businesses and CSOs in balancing the risks and opportunities of digital media for young people with protecting their rights. Holding countries to account for meeting their legal obligations and adhering to the ethical principles outlined in international human rights treaties, including the United Nations Convention on the Rights of the Child, is crucial to creating an environment that restricts corporate practices that undermine healthy and sustainable diets, lifestyles and food systems for young people (Granheim et al., 2018; Tatlow-Golden et al., 2017; UNICEF, 2018a; UNICEF and the and United Nations Special Rapporteur on the Right to Food, 2019; Verdoodt, 2019; WCRF International, 2020). The interactive and immersive nature of digital advertising and marketing affects children's rights to privacy, protection against economic exploitation, freedom of thought and access to education (Verdoodt, 2019).

In May 2010, in World Health Assembly Resolution WHA63.14, 193 United Nations Members endorsed recommendations to restrict the marketing of unhealthy food and non-alcoholic beverage products to children (WHO, 2010). In 2012, WHO published a monitoring and evaluation framework for Members to implement the Resolution, encouraging governments and CSOs to monitor digital marketing practices (WHO, 2012).

Table 2 provides a timeline of reports published by United Nations agencies, expert bodies and CSOs between 2010 and 2020, with recommendations for governments and businesses to restrict children's exposure to digital marketing that promotes HFSS products and to encourage digital marketing to be used to promote healthy food and beverage products and healthy diets. Public- and private-sector actors are encouraged to: (1) ensure that businesses abide by a strong code of practice to safeguard the best interests of the child; (2) conduct data-protection impact assessments; (3) ensure age-appropriate applications that allow transparency, prevent the harmful use of children's personal data and ensure high privacy default settings; (4) promote minimal data-collection, sharing and profiling; (5) switch geolocation options off by default for children; (6) address algorithmic nudging for children and ensure toys and devices align with these standards.

The 2020 WHO-UNICEF-Lancet Commission on the Future for the World's Children acknowledged the substantial limitations of industry self-regulatory programmes and recommended that the United Nations develop an Optional Protocol to the Convention on the Rights of the Child to protect children from the marketing of harmful products (including sugary beverages), social media and the inappropriate use of their personal data (Clark et al., 2020).

These guidelines collectively recommend that governments and CSOs hold transnational technology and food and beverage firms to account for the content they put on social-media platforms viewed by young people. More than 18 CSOs worldwide have issued position statements on digital marketing to children, requesting that governments and businesses protect children's right to health when promoting the commercial marketing content of food and beverage products and brands (World Obesity Federation, 2020).

GLOBAL AND NATIONAL ACTIONS TO REDUCE CHILDREN'S EXPOSURE TO DIGITAL MARKETING

Global actors must ensure the ethical oversight and responsible use of digital marketing and media technologies targeting young people. Table 3 proposes actions for global and national actors, including governments, United Nations agencies, CSOs and transnational food, beverage and technology firms to ensure that digital marketing and media are used only to promote healthy and sustainable diets, lifestyles and food systems.

Governments must prioritize digital privacy-protection laws and policies that restrict the digital marketing of unhealthy products and develop comprehensive codes of conduct and standards to guide policy development, implementation, monitoring and the evaluation of digital marketing practices targeted at young people. They should also engage in international and regional efforts to restrict and regulate cross-border digital marketing practices that promote unhealthy products linked to increased obesity and NCD risks (Consumers International and the Transatlantic Consumer Dialogue, 2019; WCRF, 2020).

Governments should further enforce mandatory and uniform standards and encourage transnational firms to implement best-practice recommendations and voluntary codes of conduct that protect children's digital privacy, promote digital literacy and support healthy and sustainable diets. They should also support independent research that explores the impact of digital marketing on the diet quality and health outcomes of children, adolescents and young adults (Boyland et al., 2020). Lastly, governments could collaborate with non-state actors, including international alliances (such as the NCD Alliance and the Sustainable Food Policy Alliance) to understand how digital technologies can be used to encourage consumer behaviours that are more environmentally sustainable to support the health of people and the planet (White et al., 2019).

Government and CSOs have several tools available to monitor industry progress, including the Access to Nutrition Index (ATNI), which stakeholders can use to monitor several IFBA food and beverage manufacturers' policies across seven domains, including marketing practices that influence children (ATNI, 2018). While the 2018 ATNI report found that several IFBA firms had strengthened certain digital marketing strategies after the 2016 report (such as mobile and SMS marketing and promotion through social media and company websites), more comprehensive actions must be taken. Other options to monitor industry policies include the WHO European Office's CLICK tool (Comprehend the digital ecosystem, Landscape of campaigns, Investigate exposure, Capture on-screen and Knowledge sharing) (WHO, 2018), the Business Impact Assessment tool (Sacks et al., 2019) and the Responsibility Index, which enables governments to monitor digital marketing practices amid other integrated marketing communications and to develop a policy score that can be compared with other countries (Rincón-Gallardo Patiño et al., 2020).

Technology firms should develop and align policies that protect the digital privacy rights of young people and enforce standards for digital platforms that support responsible food and beverage marketing to children and adolescents, aligned with national, regional and international laws and recommended best practices. We also suggest that technology firms post their digital marketing and media policies on their public websites in all countries where they conduct business.

IFBA food and beverage firms should amend their Global Policy on Marketing Communications to Children and apply the WHO-recommended nutrient-profile standards for food and beverage marketing to young people on all social-media platforms, including digital and mobile devices. They should also ensure that children's rights are explicitly addressed in the amended Global Policy and identify processes to mitigate the adverse impacts of digital marketing and media on children's diet, health and well-being. Lastly, IFBA firms should update and harmonize their individual policies on responsible food and beverage marketing to children with national, regional and international standards and, like the technology firms, ensure that their digital marketing and media policies are posted on their external websites in all countries where they conduct business.

CONCLUSIONS

Our globalized food system cannot sustainably promote healthy people and a healthy planet. Transnational firms widely use digital marketing and media to perpetuate unhealthy and unsustainable behaviours that contribute to obesity and NCD risks for young people, as well as climate change. This paper reviews the digital marketing and media policies of 18 transnational firms – six technology firms and 12 IFBA food and beverage companies – and how they promote products, brands and healthy and sustainable lifestyles to young people.

At the time of writing, four of the six technology firms (except Amazon Global and Microsoft) had publicly posted privacy-protection policies for children under the age of 13 years. No digital technology firm had an explicit policy on digital marketing and its use in promoting corporate brands and unhealthy HFSS food and beverage products to young people. Individual IFBA firm policies were loosely aligned with the Global Policy on Marketing Communications to Children. Only General Mills had pledged to not use digital marketing to promote HFSS food and beverage products to adolescents. No evidence was available to assess the effectiveness of IFBA firms' digital technology to promote healthy and sustainable lifestyles.

Global and national actors should make greater efforts to ensure that digital marketing and media are used to support healthy and sustainable diets, lifestyles and food systems to benefit future generations. These findings may be applicable to other unhealthy commodities promoted by businesses through digital marketing and media platforms.

Table 1. TWELVE IFBA FIRM COMMITMENTS ON RESPONSIBLE DIGITAL MARKETING TO CHILDREN AND ADOLESCENTS

Company (policy commitment year)	Countries of operation	Public commitments on digital marketing and media communications to children under 12 years	Public commitments to children aged 12–18 years
The Coca-Cola Company (2015)	> 200	• Does not advertise or market products through websites, social media, movies or SMS/email marketing (+) • Excludes sponsorship from marketing strategy (-)	• None (-)
Danone (2019)	> 120	• Marketing communications are used only to promote products that meet Danone's Pledge Nutrition Criteria (+) • Digital media covered include online and digital platforms, company-owned websites and social-media profiles, interactive games, mobile and SMS marketing, and influencers through blogs, posts, tweets and other uses of social media (+)	• None (-)
Ferrero International (2018)	55	• Does not advertise food products on the internet or on its own corporate websites (+) • Implements age-screening systems to ensure that steps have been taken to restrict viewing of advertising and the downloading of materials without parental consent (+)	• None (-)
General Mills (2019)	> 100	• Does not market any product that does not meet nutrition standards, including on blogs, message boards, chat rooms or similar forums (+) • Does not advertise on social media or any websites directed at children, engage in email marketing or encourage participation and promotion of third-party social media (+)	• Does not engage in email marketing (+) • Does not encourage participation and promotion through third-party social media (+)
Grupo Bimbo (2019)	> 20	• None (-)	• None (-)
Kellogg Company (2018)	> 180	• Does not advertise products that do not meet the Kellogg's Global Nutrient Criteria on third-party digital media/internet sites (+) • Limits children's access to the internet using age-screening devices and/or parental consent options (+) • Digital media websites do not contain content designed to appeal to or that are targeted at children under 12 years (+) • Includes an automatic use-break feature that interrupts screen-time viewing after 15 minutes (+) • Includes healthy-lifestyle messaging about energy balance, physical activity and nutrition on digital media (+)	• None (-)
Mars Inc. (2018)	78	• Does not use direct marketing communications through websites, mobile apps or other digital products and services, including online games offered on owned websites, digital advertising or other branded content made available on third-party websites and social networks, branded mobile apps, text messaging (SMS/MMS) campaigns or internet promotions (+) • Ensures that parental controls or notices are available to prevent children from submitting personal information if a social-media platform or service does not permit age screening (+)	• None (-)
McDonald's Corp. (2017-2019)	> 100	• None (-)	• None (-)
Mondelez International (2018)	160	• Does not direct or conduct marketing activities to children, be it web-based and digital media, digital apps or mobile games, social media, word-of-mouth, viral advertising, movies, video or computer games (+)	• None (-)
Nestlé SA (2018)	194	• Does not direct marketing communications to children up to 6 years of age; when directing marketing communications to children aged 6-12 years of age, the marketing is for products that meet the Nestlé Policy Nutrition Criteria (+) • Does not direct marketing communications at children for sweet or savoury biscuits, sugar confectionery, chocolate confectionery, water-based beverage products with added sugars and ice-cream products through paid or unpaid marketing communication developed directly by or on behalf of Nestlé, including digital media, mobile, games, apps, email, SMS and Nestlé-owned websites (+)	• None (-)
PepsiCo (2014)	> 200	• Marketing communications are used only to promote products that meet PepsiCo's Global Nutrition Criteria for Advertising to Children (+) • The policy applies to internet, third-party, corporate and brand-owned websites (-)	• None (-)
Unilever (2020)	190	• Does not direct marketing communications at children younger than 6 years; any marketing at children aged 6-12 years must meet Unilever's Nutrition Criteria (+) • The policy covers all digital marketing and media activities, including the internet (both company own websites and third-party websites), social media, apps, online games and direct marketing (+)	• Pledge covers all digital marketing communications and digital media intended for children under 13 years (+), but not children aged 13–18 years (-)

Source: *The Coca-Cola Company (2015); Danone (2019); Ferrero (2017); General Mills (2019); Grupo Bimbo (2019; 2020); Kellogg Company (2018); Mars Inc. (2018); McDonald's (2020); Mondelez International (2018); Nestlé (2018); PepsiCo (2014); Unilever (2020)*

Table 2. KEY REPORTS ON RESTRICTING OR REDUCING YOUNG PEOPLE'S EXPOSURE TO HFSS MARKETING, 2010–2020

Year	Report
2010	• Set of Recommendations on the Marketing of Foods and Non-Alcoholic Beverages to Children (WHO)
2011	• Digital Food Marketing to Children and Adolescents: Problematic Practices and Policy Interventions (ChangeLab Solutions and National Policy & Legal Analysis Network to Prevent Childhood Obesity)
2012	• A framework for implementing the set of recommendations on the marketing of foods and non-alcoholic beverages to children (WHO)
	• Children's Rights and Business Principles (UNICEF, United Nations Global Compact and Save the Children)
2013	• General comment No. 16 on State obligations regarding the impact of the business sector on children's rights (Committee on the Rights of the Child, United Nations High Commission on Human Rights)
	• Children's Online Privacy Protection Rule (COPPA) Final Rule Amendment • Federal Trade Commission of the United States of America
2016	• Tackling food marketing to children in a digital world: trans disciplinary perspectives children's rights, evidence of impact, methodological challenges, regulatory options and policy implications for the WHO European Region (WHO Regional Office for Europe)
	• Implementation Guide for Marketing Communications to Children Commitment (World Federation of Advertisers and Consumers Goods Forum)
2018	• A Child Rights-Based Approach to Food Marketing: A Guide for Policy Makers (UNICEF)
	• Children and Digital Marketing: Rights, risks and responsibilities (UNICEF)
	• Monitoring and restricting digital marketing of unhealthy products to children and adolescents (WHO European Office for the Prevention and Control of Noncommunicable Diseases)
	• ICC Advertising and Marketing Communication Code (2018 edition) (International Chamber of Commerce)
2019	• Resolution on the protection of children from digital food marketing (Consumers International and the Transatlantic Consumer Dialogue)
	• Protecting Children's Right to a Healthy Food Environment (UNICEF and the UN Special Rapporteur on the Right to Food)
	• Marketing of food, non-alcoholic and alcoholic beverages. A toolkit to support the development and update of codes of conduct (European Commission)
2020	• Building momentum: lessons on implementing robust restrictions of food and non-alcoholic beverage marketing to children (WCRF International)
	• Age-appropriate design: a code of practice for online services (UK Information Commissioner's Office)
	• WHO-UNICEF-Lancet Commission report on the future of the world's children (WHO. UNICEF and The Lancet)

Source: *WHO (2010; 2012); Montgomery and Chester (2011); UNICEF, United Nation Global Compact and Save the Children (2012); United Nation Committee on the Rights of the Child (2013); US Federal Trade Commission (2013); WHO Europe (2016; 2018); WFA and CGF (2016); UNICEF (2018a; 2018b); ICC (2018); UNICEF and the United Nations Special Rapporteur on the Right to Food (2019); Consumers International and the Transatlantic Consumer Dialogue (2019); European Commission (2019); WCRF (2020; Information Commissioner's Office (2020); Clark et al. (2020)*

Table 3. RECOMMENDED ACTIONS FOR RESPONSIBLE DIGITAL MARKETING TO YOUNG PEOPLE ON HEALTHY DIETS, LIFESTYLES AND FOOD SYSTEMS

Actor	Actions
United Nations agencies	• Convene actors to clarify common guidelines and standards. • Provide technical assistance to national governments (1) to develop comprehensive and cost-effective policies that restrict children's exposure to the digital marketing of HFSS food and beverage products and (2) to protect children's rights to adequate food and nutrition, health and privacy through digital marketing. • WHO and its regional offices should ensure that digital marketing is included in existing guidelines and standards to restrict HFSS food and beverage marketing to children and adolescents up to 18 years of age. • Monitor the implementation of commitments and evaluate the impact of actions to achieve targets.
National governments	• Prioritize policies that protect digital privacy and restrict the use of digital marketing to children and adolescents. • Develop comprehensive national legislation, laws and regulations to cover all forms of digital marketing aimed at children and adolescents to align them with recommended best practices (Figures 2A and 2B). • Collaborate with international and regional bodies to develop cross-border policies to regulate transnational digital marketing and media practices. • Monitor and evaluate how transnational companies are using digital marketing and social media and boost accountability for their practices in all countries where they operate. • Prohibit businesses from collecting data from children and adolescents through digital marketing, including mobile apps. • Ensure that international trade and investment agreements do not limit the ability of national governments to restrict and regulate HFSS food and beverage marketing to young people through digital marketing and media.
Technology firms	• Develop policies that protect the digital privacy rights of young people and enforce standards for digital platforms that support responsible food and beverage marketing to children and adolescents, aligning them with national, regional and international laws and recommended best practices. • Ensure that digital marketing and media policies are posted on firms' public websites in countries where they operate.
Food and beverage firms	• IFBA firms should amend their Global Policy on Marketing Communications to Children and apply the WHO-recommended nutrient-profile standards for food and beverage marketing to young people on all social-media platforms and digital and mobile devices. • Ensure that children's rights are explicitly addressed in the amended Global Policy and identify processes for mitigating the adverse impacts of digital marketing and media on children's diet, health and well-being. • Update and harmonize each firm's policy on responsible food and beverage marketing to children with the policies of national, regional and international bodies and ensure that digital marketing and media policies are posted on companies' external websites in countries where they operate.
Civil-society organizations	• Advocate and mobilize populations to demand strong government policies to protect young people' digital privacy. • Monitor and evaluate the effectiveness of voluntary commitments on digital marketing and media used to promote food and beverage brands and products to children and adolescents, as well as the impact of healthy and sustainable lifestyle programmes that use digital marketing and media to encourage healthy and responsible consumption behaviour. • Hold national governments to account and encourage transnational firms to implement best-practice recommendations and voluntary codes of conduct that protect children's digital privacy, promote digital literacy and support healthy and sustainable diets.

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Using mobile-phone technology to change behaviour: Lessons from mNutrition

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ABSTRACT

This article presents key lessons learned from a rigorous mixed-method evaluation of mNutrition, a global mobile phone-based advisory service that promotes behavioural change around key nutrition and farming practices to boost the nutritional health of children and adults in low-income countries. The evaluation found that the reach and sustained uptake of mobile mNutrition services remain a challenge among very poor households, with women often being excluded. mNutrition services currently have limited effect on nutrition and agriculture behaviours at scale, although active users (those users who adopted and engaged with the service) report some behavioural change. Still, well-designed mNutrition services can provide individually tailored, practical and context-specific advice that is often lacking from other information sources. Mobile phone-based advisory services alone tend to be insufficient to ensure uptake, engagement and behavioural change. In-person support features may help, but also raise the cost of the service.

INTRODUCTION

New, innovative approaches are urgently needed to achieve Sustainable Development Goal 2 (SDG 2) and end hunger, achieve food security and improve nutrition by 2030. Effective agricultural and health extension services are vital to achieving this goal, as they provide much-needed support and advice, especially to rural populations (Larsen and Lilleør, 2014). Yet, in many low-income countries (LICs) public agriculture extension and health services are vastly overstretched, unreliable and unable to provide adequate services to meet current and future agricultural and nutritional needs. Communities in remote areas and female farmers are often severely underserved (Bush and Keylock, 2018; Tata and McNamara, 2018).

Mobile phones may offer new, innovative channels to provide hard-to-reach populations with high-quality agriculture and nutrition advisory services and to promote improved behaviours and practices (Dia et al., 2017; Hall et al., 2015). Text (SMS) and voice-based messages may

be particularly effective delivery channels for advisory services, as they only require simple mobile phones and basic (2G) connectivity, both of which are widely available in resource-poor settings.

There is significant interest in leveraging mobile phones to promote better agricultural and nutritional behaviours and practices, yet robust evidence of their effectiveness in LICs is lacking (Barnett et al., 2016). Most studies to date are small, formative assessments of SMS-based interventions to change specific behaviours (such as breastfeeding practices) or observational studies of limited methodological quality (Aker, 2011; Lee et al., 2019; Muyaya and Manwana, 2017). So far, there is a lack of large-scale, scientifically rigorous evaluations. The objective of this article is to share key learnings from our evaluation of a mobile phone-based advisory service called mNutrition. mNutrition aimed to scale up the delivery of nutrition and nutrition-sensitive agricultural information and promote behavioural change around key nutrition practices and farming decisions to help boost nutritional health in poor households. Its services were supported by the UK's Department for International Development between 2013 and 2019, organized by the GSM Association (an industry organization that represents the interests of mobile network operators worldwide) and implemented by in-country mobile network operators. The mobile phone-based nutrition service was implemented through existing mobile agricultural (mAgri) and mobile health (mHealth) services in 12 countries throughout sub-Saharan Africa and South Asia.

We conducted a mixed-method impact evaluation of mNutrition services in Ghana and Tanzania (see Box 1 for more details on the projects evaluated). Data-collection in both countries was conducted between 2016 and 2019. The overall aim of the evaluation was to assess how effective and commercially viable the mNutrition services were in reaching poor households, increasing knowledge and improving nutrition- and farming-related behaviours. In this article, we distil key evaluation lessons for the design and implementation of mobile phone-based advisory services aimed at improving agriculture and nutrition behaviours in LICs. In particular, we impart findings on (1) the reach of mobile phone-based advisory services; (2) factors to increase the effectiveness of mobile phone-based advisory services in changing behaviours; (3) the development of effective and engaging content; and (4) the advantages of mobile phone-based services over traditional channels to change behaviour.

Box 1. mNUTRITION PROJECTS EVALUATED IN GHANA AND TANZANIA

Ghana

mNutrition was implemented through an mAgri platform called Vodafone Farmers Club (VFC). This service offered an innovative combination of customized agriculture and nutrition information through SMS, by sharing local weather updates and market prices, recorded voice messages with agricultural and nutrition tips, an expert call centre to answer farming- and nutrition-related queries, discounted tariffs and free calls and text messages to other VFC members.

Tanzania

mNutrition was implemented through the Healthy Pregnancy, Healthy Baby SMS programme, also known as the Wazazi Nipendeni SMS programme. The programme was run by the mHealth public–private partnership initiated in 2012 by Tanzania's Ministry of Health and Social Welfare. The service offered customized health and nutrition information by text message to pregnant women, mothers with newborns and male supporters to promote good health-seeking behaviour and improve knowledge and practices around optimal childcare and nutrition. Wazazi Nipendeni was not a standalone intervention, but informed by government policy, actively promoting the use of government services for additional support (for example, regular antenatal care visits during pregnancy and child growth monitoring).

1 See Barnett et al. (2017) for detailed evaluation reports on each country and IDS (2020) for more details on methodology and results.

METHODS

The evaluation used the same sequential mixed-method design for the two countries (Ivankova et al., 2006). This included three interlinked components, which we explain briefly (Barnett et al., 2017).[2]

The quantitative component

The quantitative component was designed as an experimental counterfactual design (as a randomized encouragement design in Ghana and a clustered randomized control trial in Tanzania).

Treatment households were offered the mobile mNutrition service free of charge in a door-to-door in-person visit at the end of quantitative baseline data-collection. If they agreed to sign up for the service, they were assisted through the registration process. Control households were not given the same offer, but households in either group could have learned about the service thorough other promotional campaigns.

In Ghana, quantitative data-collection took place in the Central Region and Upper West Region in 207 communities (104 treatment and 103 control). In each community, 19 farmer households were randomly sampled, for a total sample of 3 933 households at baseline in March 2017. The quantitative endline survey took place in November 2019. In Tanzania, quantitative data-collection was carried out in the three rural districts of Iringa region: Iringa rural, Kilolo and Mufindi. At baseline (October 2016), 2 833 households from 180 communities (90 treatment and 90 control) were interviewed. The quantitative endline took place in October 2018.

The qualitative component

This component comprised three qualitative data-collection rounds: an initial exploratory study, an in-depth midline case study and a rapid follow-up study. Qualitative data-collection took place in a purposefully selected sub-sample of quantitative communities in both Ghana and Tanzania. Qualitative data-collection was carried out only in treatment communities and consisted of around 100 in-depth-interviews (IDIs), 20 key informant interviews (KIs) and 50 focus-group discussions (FGDs) in each country.

All IDIs, KIs and FGDs were conducted in the local language by experienced interviewers, guided by semi-structured topic guides, audio-recorded (with consent), transcribed and translated into English. Data analysis was done using a directed content analysis approach (Hsieh and Shannon, 2005) and facilitated by NVivo software. For added rigour, data coding was done independently by two researchers and coding schemes were then discussed and merged into a joint scheme.

The business-model-and-cost-effectiveness component

This component consisted of multiple data-collection rounds, comprising stakeholder interviews, commercial and end-user data analysis, document analysis and evidence from the quantitative and qualitative components. To fully understand the complexity of the partnerships involved in the mobile mNutrition services, we used Osterwalder and Pigneur's (2010) canvas to guide the structure of the analysis.

Ethics and consent

Ethical approvals for the evaluations were obtained from the Institute of Development Studies (IDS) Research Ethics Committee and the International Food Policy Research Institute's Institutional Review Board. The evaluation in Ghana was approved by the Ethics Committee of the Humanities based at the University of Ghana. The evaluation in Tanzania was approved by the country's Commission for Science and Technology. Informed written or oral consent was collected from all participants prior to the start of the interviews.

Limitations and strengths of the evaluation

The evaluation has several limitations. First, we only evaluated two of the 12 country mNutrition projects. The findings from these two evaluations do not necessarily reflect the performance of the others. Second, the fluidity and speed of change in the digital landscape can make it difficult to evaluate the full impact and potential of mobile phone-based interventions. During the evaluation, both VFC and Wazazi Nipendeni changed on several occasions (for example, in the

2 See Barnett et al. (2017) for the detailed methodology of each component, including sampling strategies and data-collection instruments used.

number of messages sent out per month). The evaluation design was adapted accordingly without negatively impacting the internal validity of the design. A notable strength of the evaluation design was the three-pronged mixed-method approach, which allowed comprehensive insights into different aspects of the mobile phone-based services from both a user and supply-side perspective.

RESULTS

This section sets out the key lessons learned for the design and implementation of mobile phone-based advisory services aimed at changing nutrition and agricultural practices.

Reach and sustained use of the mNutrition services were low

The impact, cost effectiveness and commercial sustainability of mobile phone-based advisory services rely heavily on the total number of subscribers (McNamee et al., 2016), so reach is particularly salient. For this evaluation, we defined reach as whether and how the intended target groups took up, engaged with and ultimately used mNutrition services. We found that both the reach and sustained use of the mNutrition services were low. Only 34 percent of the treatment households in Ghana reported having used VFC at least once and 66 percent of the treatment households in Tanzania reported having received an SMS message with nutrition information at least once. In Ghana, only 27 percent of participating households had someone still signed up to VFC at the time of the endline survey. In Tanzania, only 18.5 percent of the 545 treatment households that reported ever receiving Wazazi Nipendeni had received a message in the month prior to the survey.

Mobile phone-based information services can only promote behavioural change if they reach and are taken up by the target population. Common barriers to reach and sustained engagement seen in the two studies were shortcomings in the supportive infrastructure (such as limited network coverage, difficult electricity access and multi-SIM-card behaviour, with frequent loss of SIM cards). Other barriers included limitations in the capacity of users (for example, illiteracy or limited familiarity with voice messages), issues with implementation (for instance, some users never received the mobile phone-based information service or the service was suddenly discontinued without reason) and problems in the design of the service (such as a lack of human support to profile households and encourage continued engagement). We also found that women, who often had limited access to mobile phones and were more likely to be illiterate (so could not read SMS messages), were frequently excluded from mNutrition services.

Impacts of mNutrition on knowledge and behaviours varied, but were generally small

In Ghana, we found that VFC had no impact on the nutrition, farming knowledge or behaviour of the populations that had been offered the VFC service or that had used the service at least once. Wazazi Nipendeni had some modest impacts on knowledge about infant and young-child feeding practices and on dietary diversity for women and children, but these changes did not translate into improvements in the nutritional status of children. This lack of impact can be explained in part by the low reach of the services and the very limited sustained engagement of households.

Despite the limited measurable overall impact, qualitative and quantitative sub-group analyses of active mNutrition users found a wide variety of self-reported individual changes in behaviour and practice in response to the mobile phone-based service. Users of VFC were more likely to have acted on agricultural advice than on nutrition advice. This suggests mAgri platforms may not be an effective channel for delivering nutrition advice. Our qualitative data suggests that nutrition advice was mainly valued by female farmers, who were usually responsible for all domestic chores in rural Ghana, including food preparation and childcare. In contrast, most male farmers perceived nutrition advice as not relevant and prioritized agriculture advice.

The qualitative findings suggest that human support (such as in-person training) is necessary to influence practices such as breastfeeding, or to motivate farmers to make higher-risk changes to their agricultural practices. This should be offered to complement mobile phone-based services (for example, by encouraging users to seek interpersonal support from local services). Mobile phone-based services alone cannot help households to develop the skills they need to put the information into practice.

Tailored content is important to ensure continued engagement

Households that used the mNutrition services considered most of the agriculture and nutrition advice to be easy to understand, useful and relevant. In particular, users valued the fact that the content was tailored to their specific characteristics and needs (for example, their preferred local language, location, crop cultivated or stage of pregnancy). Tailored information was highly valued and was perceived as more relevant than the general agricultural and nutrition information households usually received from health and agricultural extension workers.

Accurate tailoring of content also helped to build users' trust in the relevance of the service (which was important, as there was no human interaction to build trust and sustained engagement). The need to accurately target agricultural messages, in particular, however, can be involved, making registration processes complex. This is both expensive and difficult to manage at scale and discourages users, who prefer single-click registration processes.

Households appreciated the non-judgemental tone of the mNutrition messages, especially in Tanzania, where users contrasted it with their experience of health workers, who frequently attributed poor child nutrition (such as undernutrition) to maternal failings.

MOBILE PHONES CAN DELIVER INFORMATION EASILY AND MORE EFFECTIVELY

The evaluation identified several features that distinguished mobile phone-based information services from traditional information services for agriculture and nutrition. Mobile phone-based information services are well suited to the delivery of both area- and time-sensitive information (such as weather forecasts, market prices and time-sensitive information for different stages of pregnancy).

Moreover, they can do this more effectively and cheaply than most other information sources, even in remote, inaccessible areas (provided, of course, there is network coverage, which is often a big challenge). Mobile phone-based information is also more convenient for users, as it can be accessed at a time that best suits the recipient (for voice-based messages, this assumes voicemail is set up), as well as saved and reread or listened to again. This can help to address information asymmetries, saving time and resources on information seeking.

RECOMMENDATIONS FOR POLICY AND PRACTICES

The evaluation of the mNutrition services in Ghana and Tanzania identified the following lessons for the design and implementation of mobile phone-based advisory services in LICs. To optimize the reach and uptake of mobile phone-based advisory services:

1. **Ensure supportive infrastructure is in place:** If these requirements are not met, alternative modes of content delivery (such as radio or community outreach) or blended approaches (for example, radio and community workers) may have broader reach and be more inclusive.
2. **Consider potential gender-based exclusions from mobile phone-based services in the design phase:** In contexts where women lack sufficient autonomy over access to a mobile phone (where access is not controlled or restricted by the phone's owner) different ways of content delivery may be more effective.
3. **Design your service to match the capacity of the target group:** In areas with high literacy levels, text-based information can be cost effective. However, in areas with low levels of literacy, voice-based information may be a better option, although it is important to ensure people have the required digital literacy to access voice-based messages. It is also crucial to remember that voice-based messages are considerably more expensive than SMS and could substantially increase costs.
4. **Design features to help increase reach and uptake:** Easy registration and profiling processes, preferably assisted by a trusted person (such as a health worker or agricultural extension worker), clear sender details, so that messages are not mistaken for spam, and the possibility of linking service use to more than one SIM should be considered when designing such services to increase reach and uptake.

To increase the effectiveness of mobile phone-based services in changing behaviour:

1. **Introduce interactive components** (such as call centres) **and face-to-face contact** (such as local support groups) to promote behaviour change. Do not rely solely on 'pushing out' information to passive audiences.
2. **Combine mobile phone-based information services with financial services or ongoing interventions** (such as livelihood improvement programmes or social protection programmes) that provide poor households with the

financial resources needed to act on the information. Users of mobile phone-based services can only act on information if they have the financial resources to do so.

3. **Integrate a mobile phone-based information service into existing programmes or policies** (as was done in Tanzania), where such services can help to reinforce and embed existing knowledge and ultimately change behaviour.

To develop engaging content:

1. **Provide practical, low-cost advice** that is actionable and achievable. This type of hands-on information is often missing from other services. Rather than advocating for evidence-based best practices, messages need to be context-specific and feasible in resource-poor settings.
2. **Ensure that content is carefully tailored to individual characteristics and information needs, as poor targeting can quickly result in disengagement.** However, tailoring is time-consuming, laborious and difficult to conduct at scale.
3. **Consider alternative channels to engage male farmers with nutrition issues.** Our findings from Ghana show the inclusion of nutrition tips in mAgri platforms is valued by female, but not male farmers. Alternative channels are needed to involve men in nutrition (for example, nutrition education during antenatal care sessions that are mandatory for both parents). Given female farmers' interest in nutrition advice alternative channels that only deliver nutrition information might also be more engaging, as they are more focused (for example, mobile phone-based nutrition services).

Consider the use of mobile phone-based information services:

1. **Where access to timely information is a challenge** (for example, because of limitations on public extension services). For instance, in Ghana, farmers valued time- and area-sensitive weather, market prices and agricultural information delivered to their mobile phones. In Tanzania, users appreciated information tailored to each week of pregnancy and early childhood.
2. **Where routine access to information is a challenge.** In both Ghana and Tanzania, users valued the regular flow of information on agriculture, health and nutrition. Mobile phone-based services can be especially useful in terms of supporting overwhelmed and underfunded public services that can only provide very limited contact time for each household.

CONCLUSIONS

Mobile phone-based services are not a magic bullet, but they are valued by users who engage with them, so could be a valuable addition to programmes aimed at improving nutrition and agriculture-related knowledge and changing behaviour. Mobile phone-based advisory services alone tend not to be enough to affect nutrition outcomes, which generally have complex determinants. Human interactions are vital to support, facilitate and ensure sustained engagement with the services.

There are still multiple outstanding implementation and programmatic issues with mobile phone-based advisory services that hamper large-scale reach, uptake and sustained engagement. Mobile phone-based services can also generate new inequalities, as poor households that cannot afford a phone are excluded from the service (and were excluded from this evaluation). There is a risk that the poorest and most marginalized will be left behind by such services (Hernandez and Roberts, 2018).

Mobile phone-based services to change behaviour are likely to be most effective if embedded in trusted structures (such as agriculture extension services), if they are linked with other programmes that address underlying barriers to change (such as social protection programmes) and paired with established low-tech, inclusive approaches (such as radio).

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IFAD/SIMONA SIAD

Social networking for nutrition: Educational intervention in the digital age

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ABSTRACT

A growing number of people are seeking tools to transform and facilitate their daily choices, including those associated with food. Health professionals need to recognize, adapt and respond to this demand and, to do so, must focus on the individual. Social networks have revolutionized the way in which people communicate and are a useful tool for raising nutritional awareness. When using social networks, however, health professionals need to be cautious and prepared and have an in-depth knowledge of their target communities.

To explore the possibilities of social networking for nutritional education, the University of São Paolo's 2019 @nutrinterativa study aimed to identify the sociodemographic characteristics of a group of adults in a virtual environment, along with their preferences, wants and needs. It was a quali-quantitative study conducted using a survey developed in Google Forms. The data were evaluated based on frequency and percentage distribution and later processed using R software.

The 281-strong sample contained a preponderance of women and young people (between the ages of 18 and 39) and were largely located in south-eastern Brazil. Most had not received any nutritional counselling prior to the survey. The social network most often used for general communication was WhatsApp, but Instagram was more often used to search for nutritional information. Participants voiced interest in a wide range of nutritional topics, many of them directly related to the pathophysiological and dietary aspects of disease. The survey suggested that information should be presented as infographics and that social-media interventions should be conducted individually, more than five times a week.

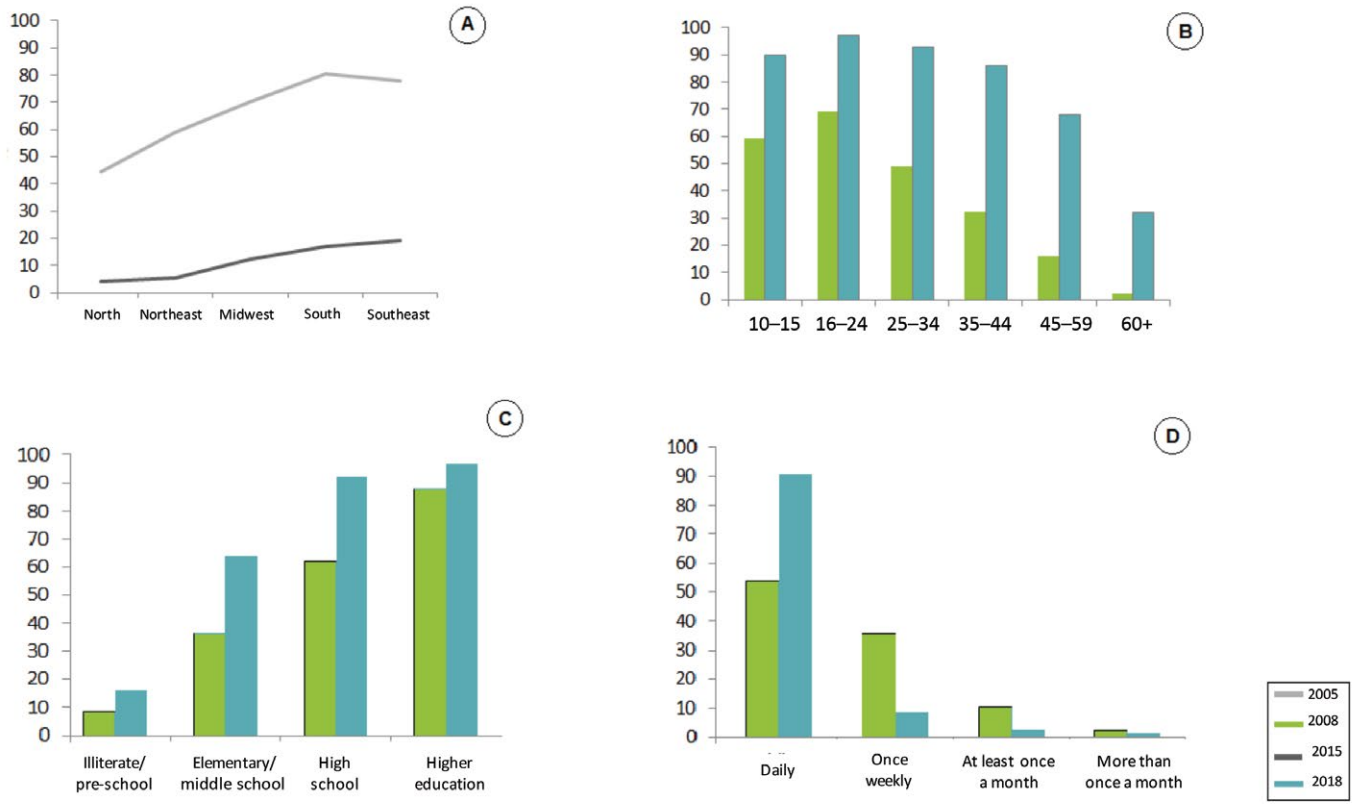
The huge amount of interest and variety of preferences in terms of topic and presentation of content gave researchers a wide range of possibilities to work with. The study concluded that, just as in face-to-face interventions, individual characteristics need to be taken into account in social-media actions to ensure they meet needs and demand and are, ultimately, effective.

INTRODUCTION

Technological developments, particularly in recent decades, have significantly altered the ways in which people communicate and society interacts. This continuum has modified lifestyle and dietary patterns, as manifest in the nutritional transition (Brazil 2012). It is crucial, therefore, that health professionals monitor these changes and adapt their way of working to bring quality information to individuals. Social networks are an important resource in this regard, as access to these tools is on the rise (International Telecommunications Union, 2018).

Brazil's Continuous National Household Sample Survey (Continuous PNAD) shows that from 2005 to 2015, there was a huge increase in Brazilian access to the internet, regardless of region analysed. While in 2005, less than 20 percent of households in any region had computers connected to the internet, in 2015, this had increased substantially (Figure 1A) (IBGE, 2006; 2016). Moreover, the number of people who had accessed the internet at least once in their life had increased, regardless of age (Figure 1B) or level of schooling (Figure 1C). There was also a rise in the percentage of people who accessed the internet on a daily basis (Figure 1D) (Brazilian Internet Steering Committee, 2009; 2019).

Figure 1. BRAZILIAN INTERNET CONNECTIVITY, 2005–2015



Note: *A = percentage of households with microcomputers connected to the internet by region; B = percentage of people who already accessed the internet by age range; C = percentage of people who already accessed the internet by level of schooling; D = percentage of people who already accessed the internet by frequency of use.*

Source: *Data adapted from IBGE (2006; 2016); Brazilian Internet Steering Committee (2009; 2019)*

The number of nutritional education studies carried out with adults in face-to-face situations far exceeds the number conducted in the virtual environment, especially in Brazil (Machado et al., 2016; Silva e Quintão, 2015; Cervato-Mancuso, 2016). In terms of promoting nutrition education, McKinley and Wright (2014) observe that informative support in a virtual environment can encourage people to a search for a healthier lifestyle. Similarly, Alssafi and Coccia (2019) note the potential of social networks to improve food choices when it comes to fruit and vegetables. As with face-to-face interventions, when using social networks to communicate information or to develop health-education interventions in a virtual environment, it is essential to respect individuals' characteristics, needs and preferences.

The University of São Paulo's @nutrinterativa study on nutritional education programmes in the virtual environment, conducted in 2019, aimed to identify the profiles and preferences of adults in Brazil who showed interest in participating in online nutritional education programmes. The ultimate goal was to help streamline and tailor the sea of (often conflicting) nutritional information available online for those who needed it quickly and free of charge.

METHODOLOGY

The @nutrinterativa study was quali-quantitative, using Google Forms to create an online survey that included an informed consent form approved by the university's ethical committee. To participate, respondents had to be adults and able to use social media, such as WhatsApp, Messenger and Instagram. They were asked to provide basic details (sex, age, region) and to give their views on a range of sociodemographic topics and issues in a series of open- and close-ended question, such as: access to nutritional counselling, use of social networks for general communication and access to health information (through WhatsApp, Facebook Messenger, Instagram and others), pre-selected topics of interest, preferred content presentation formats, individual or group participation preference, time-of-day communication preference (morning, afternoon or night) and frequency-of-communication preference. Twenty-one topics of interest were pre-selected from four areas: diet-related diseases (such as hypertension, diabetes and gastrointestinal diseases); nutrition science (for example, food processing techniques); fad diets (for

example, intermittent fasting, a low-carb diet, the benefits of tea or intuitive eating); and food allergies and intolerances. Respondents could also suggest other topics.

A link to the questionnaire was disseminated through the faculty newsletter, aimed at students and university staff, and published in the university's virtual journal, targeted at the academic and non-academic community. All adults able to fill in the form could participate in the study, including health professionals, as they could enrich group discussions and learn about new possibilities for care. Respondents were able to reply in June and July 2019. The collected data were evaluated by frequency and percentage distribution on R software, version 3.6.1. The viability of the questionnaire was pilot-tested on a sample of 20 Brazilian adults.

RESULTS

The questionnaire was completed by 281 adults from different regions of Brazil (n=279), as well as one each from Portugal (n=1) and France (n=1). The sociodemographic profile is presented in Table 1.

Table 1. SOCIODEMOGRAPHIC PROFILE OF INDIVIDUALS PARTICIPATING IN THE STUDY

	Number of participants	% of total
Sex		
Female	218	77.58
Male	62	22.06
Other	1	0.36
Age		
18-29	76	27.14
30-39	72	25.71
40-49	54	19.29
50-59	52	18.57
60+	26	9.29
Region		
Midwest	6	2.14
North	4	1.42
Southeast	235	83.63
Northeast	24	8.54
South	10	3.56
Abroad	2	0.71

Source: *@nutrinterativa project, São Paulo, 2019*

Most respondents said they had never received nutritional counselling prior to the survey. Of those who had, the majority had seen a nutritionist (Table 2).

When asked about the use of social networks for general communication, most respondents said they tended to use WhatsApp, followed by Facebook and Instagram. While less commonly used, Instagram was cited as the social network most used for searches on nutritional information (Table 3).

Table 2. PREVIOUS NUTRITION COUNSELLING EXPERIENCE OF PROGRAMME PARTICIPANTS

Received counselling	Number of participants	% of total
Yes	123	43.77
Physical trainer	4	3.25
Physician	21	17.07
Nutritionist	98	79.67
No	158	56.23

Source: *@nutrinterativa project, São Paulo, 2019*

Table 3. SOCIAL NETWORKS USED BY PARTICIPANTS TO COMMUNICATE AND ACCESS NUTRITIONAL INFORMATION

WhatsApp		Number of participants	% of total
Yes		276	98.22
Nutritional counselling			
	Yes	31	11.23
	No	245	88.77
No		5	1.78
Facebook		**Number of participants**	**% of total**
Yes		178	63.35
Nutritional counselling			
	Yes	59	33.15
	No	119	66.85
No		103	36.65
Instagram		**Number of participants**	**% of total**
Yes		161	57.30
Nutritional counselling			
	Yes	81	50.31
	No	80	49.69
No		120	42.70
Other digital media		**Number of participants**	**% of total**
Yes		100	35
YouTube		12	12
Twitter		3	3
Blogs		8	8
Pinterest		3	3
Google		23	23
Email		5	5
Apps		2	2
TV		2	2
Magazines		3	3
Scientific articles		3	3
Books		3	3
Journals		7	7
Sites		26	26
No		**181**	**64**

Source: *@nutrinterativa project, São Paulo, 2019*

Those who said they used WhatsApp to obtain nutritional information did so as members of social-network groups on food and nutrition, which tended to be formed by acquaintances. There were also those who used social media to communicate with nutrition professionals they had already met face to face. Respondents also mentioned that they used WhatsApp to share content retrieved from other social networks (Facebook and Instagram), especially to friends and family.

Do you use WhatsApp to obtain nutritional information? If so, how?

- "Yes, nutrition groups" (Participant 265)
- "Yes, friends' groups" (Participant 104)
- "Yes, resolving doubts with a nutritionist when necessary" (Participant 169)
- "By posting friends' posts from Facebook or Instagram" (Participant 243)

Facebook users said they accessed nutritional information through pages on certain themes and from articles and recipes posted by other segments' pages (such as local journals). Some belonged to Facebook groups focused on health foods, nutritional education or low-carb diets.

Do you use Facebook to obtain nutritional information? If so, how?

- "Yes, I follow some pages related to food" (Participant 159)
- "Yes, I follow profiles and pages of nutritionists" (Participant 71)
- "Yes, I am part of a low-carb diet group, where members share motivational messages and recipes" (Participant 150)

Instagram tended to be used to follow nutritionist profiles and, to a lesser extent, trusted nutrologists, in addition to non-health professionals and influencers known for espousing certain lifestyles. Instagram was also used to access information on nutrition by following specific hashtags, such as #inflamatorydiet and #veganfood.

Do you use Instagram to obtain nutritional information? If so, how?

- "Yes, through posts from nutritionists and nutrologists that I find reliable" (Participant 56)
- "Yes, I follow some people who eat well and mirror them" (Participant 46)
- "Yes, I follow the hashtag #inflamatorydiet to learn about good/bad foods for me" (Participant 173)

Respondents said they would prefer to participate in individual nutrition education sessions, mostly over WhatsApp, though most said they would be open to group participation. The opposite was true for those who initially opted for group participation. There was no difference in preference for morning, afternoon or night-time intervention, but a greater percentage of respondents said they would like to receive information five or more times a week (Table 4).

Table 4. COMMUNICATION PREFERENCES OF SURVEY PARTICIPANTS

Social media		**Number of participants**	**% of total**
Instagram		37	13.17
Messenger (Facebook)		11	3.91
WhatsApp		233	82.92
Format		**Number of participants**	**% of total**
Individual		152	54.09
	Would you agree to be part of a group?		
	Yes	118	77.63
	No	34	22.37
Group		19	6.76
	Would you agree to be part of a group?		
	Yes	17	89.47
	No	2	10.53
Indifferent		110	39.15
Preferred time of day		**Number of participants**	**% of total**
Morning (06.00–12.00)		112	39.86
Afternoon (12.00–18.00)		105	37.37
Night (18.00–22.00)		64	22.78
Submissions per week		**Number of participants**	**% of total**
1–2		54	19.22
3–4		83	29.54
5 +		144	51.25

Source: *@nutrinterativa project, São Paulo, 2019*

When it came to the topics on which they would like to receive information, more people selected "tea and its benefits for health" (n=159), "extent of food processing" (n=140), "gastrointestinal diseases" (n=137) and "intuitive eating" (n=135)). New topic suggestion was low, but there was considerable interest in "vegan/vegetarian/raw food diet" and "thyroid disease". Participants said these topics should be presented as dietotherapy-related cooking recipes or advice to optimize food preparation time. Moreover, they indicated that the information should also be summarized as infographics (Table 5).

Table 5. DISTRIBUTION OF CONTENT AND PRESENTATION FORMATS CHOSEN BY RESPONDENTS

Format	Number of participants	% of total
Animation	71	25.27
GIFs	83	29.54
Images	138	49.11
Text	90	32.03
Video/Live	112	39.86
Infographics	229	81.49
Quiz	1	–
Content	**Number of participants**	**% of total**
Detailed explanation	58	20.64
Questions to ponder	34	12.10
Recipes	101	35.94
Scientific article summary	46	16.37
Weekly summary	37	13.17
All options	5	1.78

Source: *@nutrinterativa project, São Paulo, 2019*

DISCUSSION

Before discussing the survey results, it is necessary to consider the limits of the virtual environment as a platform for nutrition professionals to act. Brazil's Nutritionist Code of Ethics states that is a nutritionist's duty to make the promotion of health and food and nutrition education their main objective when sharing information about food and nutrition on various media. Information must be shared in a critical and contextualized manner, backed up by technical-scientific data. Nutritionists are not allowed to use the virtual environment to conduct assessments that require face-to-face interaction, such as anthropometric tests. The @nutrinterativa study adhered to these rules at all stages. Nutritionists using virtual environments to perform nutritional education work need to be fully aware of these regulations.

While growing significantly, the use of social networks for general communication and for accessing information on nutrition and health it is still low, both in Brazil and globally. Academic literature on the theme is also limited (International Telecommunications Union, 2018). Users of the social-networking environment for communication on nutrition and health must take quality issues into account: greater access to digital tools does not necessarily mean access to better-quality content; indeed, the opposite may be true. It is equally crucial to consider general literacy levels – reading and writing – as these are a prerequisite to promoting equal access to knowledge and information (UNESCO, 2017). There needs to be a firm commitment from governments to improve general literacy alongside efforts and investment to expand access to digital technologies.

Despite primarily targeting students and university workers, some respondents found it difficult to fill in the electronic form. Some of them asked family members for help, while others simply gave up. As Google Forms only registers completed questionnaires, it was not possible to estimate the number of unsuccessful attempts to respond. The views of those who did not complete the survey is highly relevant, however. We can hypothesize that low general literacy, in addition to low digital literacy, limits the success of virtual health and nutrition education.

We noted the preponderance of female respondents in the survey. Prior studies evaluating the determinants of access to health services, either in person or remotely, found the same (Lemos et al., 2017; Levorato et al., 2014; El-Kour et al., 2018). While the lower participation of male subjects in in-person health interventions might be attributable to differences in availability due to employment, it is necessary to investigate the determinants hindering male participation in online health interventions. Understanding individual perceptions of interventions developed in the digital environment, by gender and other sociodemographic factors, can contribute to health promotion efforts.

The participation of adults who had never previously received nutritional counselling reinforces the importance of health professionals communicating quality nutrition and health information through different media and underscores the importance of democratizing access to nutritional information. Those who had previously received nutritional counselling had mostly seen a nutritionist, though some had received nutrition advice from another health professional, such as a physician or a physical trainer. Although the latter cannot prescribe diets in Brazil, they often disseminate information and stimulate critical thinking on the importance of healthy diets and health promotion more generally.

While previous surveys had found older people (aged 65 and over) reluctant to participate in online nutritional education actions (Loehmer et al., 2018), the @nutrinterativa study painted a different picture. Without targeting specific audiences, around 10 percent of respondents were aged 60 or over. This may reflect how much traction technology has gained in Brazil. If the survey were conducted again, we would not be surprised to see an even greater percentage of older participants.

While Brazilian respondents were more interested in receiving nutrition-related content over WhatsApp, a 2019 global survey found a preference for Facebook (Perrin and Anderson, 2019). The difference appears to be down to a cultural preference for the former, despite other free apps with similar functions. It is important to note that respondents associate such apps with the strengthening of their interpersonal relationships, which influences their preferences.

While it is broadly recognized that group participation can contribute to individual self-transformation (Bastos, 2010), the @nutrinterativa survey found a preference for individual nutrition counselling. This needs to be taken into account if an intervention is to succeed. While encouraging participation in other formats that take participants out of their comfort zones can enhance the learning experience, it can be a negative experience for some and hamper participation, compromising the entire process. Thus, more studies that investigate what boosts or compromises participation are needed.

Communication and knowledge-building processes must be considered in virtual environments, just as they are in face-to-face methodologies. Participants in virtual environments have different interests and styles of learning (Manolis et al., 2013). These differences need to be recognized and included in personalized projects. The @nutrinterativa survey shows the diversity of preferences. Staging nutrition counselling with a lack of options may prove problematic, making them ineffective in meeting the needs of those involved.

Further studies are required to fully understand and effectively explore the potential of virtual nutrition education interventions and, thus, empower people to choose healthy diets. However, it is essential that health professionals prepare prior to engaging in this new, virtual arena by exploring new strategies and ideas to promote health, nutrition and well-being.

Lastly, it is important to note the potential of using virtual environments for conducting certain types of scientific survey, regardless of the field of knowledge. By applying the correct methods, participation can be enhanced and democratized to complement scientific developments. Operating costs are also reduced, as surveys can be created, used and distributed at a lower cost than printed questionnaires or in-person survey methods.

CONCLUSION

The use of social networks by nutrition and health professionals for conducting nutritional education remains rare,but is gaining traction among those who have already incorporated digital media into their daily routines, especially those people with an interest in nutritional information.

Individual needs, preferences and characteristics must be considered when planning face-to-face nutritional education interventions. This study shows that personalization is equally important for interventions taking place in virtual environments. Ignoring these details may decrease success rates. This duty of care should not be overlooked by healthcare professionals operating in the virtual space. While they often acknowledge the complexity of the digital arena, they should be better armed with knowledge and insights to generate expected results.

The perspectives for virtual nutrition counselling using social networks highlighted by this study can hopefully provide some insights that will help pave the way for those planning to develop personalized and more effective virtual nutrition interventions through these channels.

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Social-media discussion analysis as a tool for nutrition practitioners

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ABSTRACT

There is a growing body of evidence showing that social-media discussion analysis can be used by practitioners, programme managers and other decision makers to improve nutrition-related activities, nutrition literacy and food environments. Our qualitative analysis of 84 social-media discussion posts centred in Ottawa, Canada, produced three key observations: (1) participants used social media to seek advice and share recommendations on grocery shopping, revealing what food-environment characteristics were important to them; (2) participants provided perspectives on what they liked, disliked and did not understand about nutrition-related programmes; and (3) social media provided a space for people who might never meet in real life to engage with, learn from and support one another. Consequently, we argue that social-media discussions can be used for two purposes: to disseminate evidence-based, informed nutrition information to improve nutrition literacy and to gain insights into publicly available discussions on nutrition-related issues, enabling the inclusion of more diverse citizens' perspectives when designing and evaluating nutrition-related programmes and policies.

INTRODUCTION

This paper describes the opportunities for nutrition practitioners, programme managers and other decision makers (which we will collectively refer to as "practitioners" in this paper) to use social-media discussion analysis to improve nutrition-related activities, nutrition literacy and food environments. Many of the challenges surrounding nutrition have been described as "wicked problems", as stakeholders can have contrasting definitions, values and viewpoints and there are no clear solutions (Head, 2008). These wicked problems include obesity, food insecurity, food marketing and sustainability (Haysom et al., 2019; Rush, 2019). Solving them requires researchers to seek out diverse perspectives and develop new research approaches (Head, 2008; Rowbotham et al., 2019; Termeer et al., 2013).

One intriguing approach lies in "citizen science", which draws on the public as "citizen scientists" to play a larger role in helping to solve the challenges facing them. The opportunities of citizen science have the potential to provide new insights and even solutions to nutrition's wicked problems and promote a culture of public engagement with issues of public interest, such as creating public programmes that are better aligned with public needs (Park and Conway, 2017; Rowbotham et al., 2019). There are different models of citizen science (Bonney et al., 2009):

- The contributory model of citizen science involves practitioners defining the questions and citizen scientists contributing data.
- The collaborative/co-created model involves practitioners and citizen scientists working together through the entire process of defining problems to suggesting solutions.

The collaborative/co-created model of citizen science involves the highest degree of public engagement and has been successful in improving food environments (Chrisinger et al., 2018; McKerchar et al., 2019; Sharif et al., 2017). But this approach is also costly, resource- and time-intensive for both participants and practitioners (Chrisinger et al., 2018; Jernigan et al., 2020) and, like traditional methods, has self-representation biases and recruitment challenges (Kozinets, 2019; Pavalanathan and De Choudhury, 2015).

In contrast, in settings where resources are limited and/or recruitment through traditional methods has been challenging, we would encourage practitioners interested in citizen science to focus on a version of the contributory model using social-media discussion analysis. Importantly, this approach for engaging with the public is not suggested as a replacement for traditional approaches, but as a complement, to generate new opportunities and insights (Kozinets, 2019; Rowbotham et al., 2019).

Thus, in the following article, we first describe social-media discussion analysis, then present an example of how we have used social-media analysis in our work to assess the food environment in Ottawa, Canada. We argue that social-media analysis presents a fruitful opportunity for nutrition practitioners in their work to develop and evaluate nutrition programmes and improve nutrition literacy.

Social-media discussion analysis

The exponential growth of social media presents opportunities for nutrition practitioners to see how the public discusses nutrition-related topics, information that can be used when developing programmes and policies aimed at improving the food environment and disseminating nutritional information. Analysing social-media discussions offers distinct advantages for practitioners (Hookway and Snee, 2017; Pavalanathan and De Choudhury, 2015):

- It offers access to insights that have not been influenced by the presence of a practitioner.
- It requires no physical travel.
- Discussions are generally archived and stored, allowing access to current and past views.
- It is an especially useful way to seek input from hard-to-reach populations.
- The discussion context has been found to encourage participants to reveal more information than traditional methods.

There are also challenges associated with social-media discussion analysis (Kozinets, 2019; Markham and Buchanan, 2015; Tiidenberg, 2018):

- The credibility and quality of social-media data require special attention.
- There are a number of ethical questions around collecting this type of publicly shared data.
- Social-media data often present a sampling bias, as certain groups are underrepresented.

Thus, while not without challenges, the strength of this approach lies in its ability to uncover diverse, new and outlying perspectives, which may prove critical in addressing the wicked problems currently facing nutrition (Rowbotham et al., 2019). A growing body of nutrition research has used social media to assess multiple aspects of food environments, and with good reason: thousands of people are already engaged in recording and publicly posting details about nutrition-related topics, such as access to healthy food and their views on nutrition-related policies (Gregg et al., 2017; Rowbotham et al., 2019).

Quantitative researchers have analysed:

- Instagram for insights into obesogenic environments (Munk et al., 2016)
- Twitter to examine exposure in food environments (Chen and Yang, 2014)
- Yelp to examine the consumer nutrition environment (Gomez-Lopez et al., 2017; Shen et al., 2019)
- Yelp and Twitter combined to examine associations between food-environment characteristics and state-level health outcomes (Nguyen et al., 2017)
- Various types of social media to examine food-borne illness outbreaks (Effland et al., 2018; Nsoesie, Kluberg and Brownstein, 2014; Oldroyd, Morris and Birkin 2018).

Qualitative and mixed-method researchers have examined:

- message-board discussions of teachers' experiences with school healthy-eating practices and policies (Lynch, 2015)
- online news-article comments to investigate public perceptions of obesity policy (Gregg et al., 2017), lab-grown meat (Laestadius and Caldwell, 2015) and the closure of a fast-food restaurant (Lynch et al., 2019)
- blogs to better understand first-hand experiences of food insecurity (Elliott, Squire and O'Connell 2017; Howarth, 2017).

As others have found in our decade of using social media to examine public discussions on nutrition issues, we have been able to uncover additional insights into the food environment that had not been captured using traditional methods. We will now turn to an example of using social-media data to gather insights into the local food environment in Ottawa.

Social-media analysis to seek public perspectives on Ottawa's food environment

As part of a larger study on retail food environments in Ottawa, we analysed message-board discussions and online news-article comments to explore social norms related to food shopping in Ottawa. Retail-store settings have become of increasing interest to municipal governments and public health practitioners as settings for healthy food interventions (Minaker et al., 2016). When we began our study, Ottawa's public health unit had just completed a two-year programme that brought fresh fruit and vegetables into seven convenience stores in Ottawa's low-income communities. We wanted to investigate what we could learn from social-media discussions for use in programmes to improve retail food environments. Here, we present a qualitative analysis of the social-media data to illustrate how nutrition practitioners can consider social-media data as a timely, feasible and cost-effective tool when designing and evaluating nutrition programmes and services.

DATA-COLLECTION AND ANALYSIS

It is beyond the scope of this article to provide a complete description of our methodology and we would direct interested readers to publications that provide detailed information on how to conduct qualitative social-media discussion research (Hookway & Snee, 2017; Kozinets, 2019; Laestadius & Caldwell, 2015; Lynch, 2015).

We examined social-media discussions from two online message boards and the comments associated with three online news articles between 2015 and 2018, which focused on grocery shopping, with a particular emphasis on shopping for fresh fruit and vegetables.

Due to its popularity, discussions from online message board Reddit made up most of our data. Once we were on the Reddit website, we focused on the message-board section dedicated to Ottawa, specifically discussions in the section "r/Ottawa", which had 44 700 registered participants. We searched r/Ottawa for discussions about grocery shopping by typing key words into the search engine, for example, "groceries", "vegetable", "fruit", "fresh produce" and "veggie." We excluded restaurant reviews, lists of the best restaurants in Ottawa, recipe articles and food-recall warnings. To supplement the Reddit discussions, we repeated this search on a comparatively smaller Canadian message board. In total, we collected 81 message-board discussions.

To locate news-article comment sections, we similarly typed terms into Google and applied the "news" filter: "Ottawa fruit and vegetables" and "Ottawa grocery." We removed any articles where we could not reasonably discern Ottawa commenters. From this second search, we collected three comment sections appended to online news articles.

We then analysed the discussions using thematic analysis. Both researchers read and re-read the 84 social-media discussions, searching for patterns. We analysed what language was used, what ideas dominated the discussions and what opinions participants were trying to convey. We held regular meetings to discuss our emerging themes and resolve any discrepancies. Ultimately, we agreed on three key themes that could help practitioners in their work.

RESULTS

1. Food-shopping information

Ottawa residents used social media to seek advice and share recommendations on fresh food and vegetable shopping. Most frequently, discussions were initiated by a participant asking for recommendations on where to buy affordable fresh fruit and vegetables, with discussions simply labelled "cheap vegetables". Other discussions were initiated by a participant asking for suggestions on where to find "deals" on fresh fruit and vegetables. These discussions were filled with participants discussing various suggestions and tricks for finding the most affordable groceries in the city, such as the food-retail locations that sold the cheapest produce, and "stocking up" on fresh fruit and vegetables when they were on sale. We also noted how, in discussions about purchasing affordable groceries or tips for lowering grocery bills, eating more fresh fruit and vegetables and plant-based proteins was recommended:

> *We try to stick to healthier stuff (fish, turkey, pork) but the reality is none of it is going to be as cheap as a brick of tofu or beans … for example, paying 5 bucks for some ground beef to add to chilli when it you can just add some 99 cent refried beans instead.*

Many of these discussions specified the area in the city in which the participant was interested and involved participants discussing which grocery stores, small food stores and other vendors sold the cheapest produce. In one discussion, a participant asked:

> *I've been seeing a lot of people suggest buying straight from the source for fruits and veggies and I was wondering if we have that here. I have been to a few of the farmers markets around like Lansdowne, Parkdale and Westboro [Ottawa neighbourhoods] but the prices aren't as low as I've been seeing others finding.*

Throughout the discussions, we repeatedly identified participants sharing information on unique discounts at food-retail locations, such as grocery stores that sold fresh fruit and vegetables with minor imperfections at a discounted price. We also found discussions with participants recommending the best day of the week to shop: "Most flyers begin on Thursdays so try to schedule your grocery day on that day if you can." And even the best time of day to shop: "One of the fruit stands at Byward [a fresh fruit and vegetable market] regularly offers an end-of-day discount to get rid of stock." Participants also shared information on their perceived limitations of stores. "As someone else mentioned, Kaladar market [small food store] for produce. It's obscenely cheap and high quality. Only downside is limited hours and cash only," said one participant. "FreshCo [discount grocery store] is ok sometimes, but I hate their no backpack rule," said another.

2. Nutrition programme feedback

In our search, we discovered a few message-board discussions that specifically discussed Ottawa Public Health's retail food-environment programme, which involved bringing fresh fruit and vegetables into convenience stores. A few participants expressed interest and positive reactions to the food-environment initiative, stating how they wished there were a similar programme where they lived. Another participant revealed a personal connection to the programme:

> *It'll be interesting to see the results. I used to live in one of the "food deserts" served by this project and I would've loved to be able to get reasonably priced fruits and vegetables in my neighbourhood. I ended up having to buy a lot of frozen produce, which while just as healthy, is limiting.*

However, more often, we found participants expressed criticism of the programme, sharing how they viewed it as unnecessary, because they believed the area of the city being targeted by the programme already had "plenty of fresh food options within a walking distance". Participants also noted that there were more important issues on which the public health unit should focus: "How about public awareness campaigned about the dangers of excess sugar (especially fructose) in every single item in the corner store?" Others believed that initiatives already existed to address the issue of accessible fresh fruit and vegetables. Some participants were critical of the programme being effective in any part of the city – "doubt many people will even buy, more food going to waste" – and pointed out that "there's definitely a perception (rightly or wrongly) that convenience store produce is low on quality and high on price. It'll be hard to fight."

We observed how participants in this discussion on the public health unit's retail food-environment programme, as well as in discussions about access to fresh fruit and vegetables in general, described wanting more information to be made available online on the foods sold at retail outlets. One participant asked: "Does anyone know more about this initiative, like what it is actually called, or how to get involved or what I can do to help get this near me?" This question was left unanswered. In other discussions about fresh fruit and vegetables, participants would occasionally reply, "Can't you just google it?" Other times, participants described their frustrations with being unable to find information on a retail food location online. While this may be unsurprising, coming from discussions between people who are comfortable communicating online, we note that the public health unit's evaluation of the corner-store programme also found that several store owners described how much they benefited from the social-media coverage their stores received for participating in the programme.

3. Community engagement

Lastly, we observed how social media appeared to provide Ottawa residents with a unique space to interact with a variety of individuals and share descriptions and personal

experiences of the capital's food environment. In some of the discussions, participants revealed themselves to be employees of retail food locations and offered their "insider" tips. In one discussion about affordable vegetables, an individual who worked at the Ottawa Good Food Box, an initiative to increase access to fresh fruit and vegetables, replied to a comment with: "I am a site coordinator in town for the Good Food Box and the boxes are always very well received."

In other discussions, participants who worked at grocery stores offered advice. One participant replied to a question on where to purchase a specific food: "I work at a Loblaws [grocery store]. Our store did carry it, but like a month ago it was on clearance and we haven't had any since." In a discussion about purchasing fresh fruit and vegetables that are local to Ottawa, a participant revealed: "I work at Farm Boy [grocery store] and obviously, there's a limit to how much local produce they can get (winter being a tough time), but they do their best to support local." Notably, in one discussion, we saw suspicion that the original poster was promoting a restaurant and not an "authentic" participant, with another participant posting: "This feels like an ad."

Participants expressed gratitude for advice from fellow participants, describing their intention to follow up on the suggestions offered and saying how valuable it was to receive advice in this format: "Thank you for the info and replies so far everyone, please keep them coming! It's great and very helpful to get a bit of personalized info from all the different choices" and "thanks I'll take a look at it this weekend". Camaraderie was evident throughout, such as one discussion initiated by a participant asking for advice on where to purchase a specific brand of drink. Another participant posted a photo he took of the brand in one retail food location, describing how he remembered the discussion while he was grocery shopping. The original participant replied: "Whoa, did you go out of your way to take that? Thanks a bunch."

DISCUSSION

Three main themes emerged from this study:

- Participants used social media to seek advice and share recommendations on fresh fruit and vegetable shopping, revealing what food-environment characteristics were important to them. These findings contribute to a growing body of both qualitative and quantitative evidence that demonstrates how social-media data can provide information on various food and nutrition-related factors of local nutrition environments (Effland et al., 2018; Gomez-Lopez et al., 2017; Lynch et al., 2019; Nguyen et al., 2017; Shen et al., 2019).
- Participants provided perspectives on what they liked and disliked about nutrition programmes. Previous research has similarly found social-media discussions can provide important feedback on the public's understanding of, and receptiveness to, nutrition policies and programmes (Gregg et al., 2017; Laestadius & Caldwell, 2017).
- Social media provided a space for people who might never meet in real life to engage with, learn from and support one another. These findings corroborate other research that has noted how social media provides people with unique opportunities to connect and provide social support (Hookway and Snee, 2017; Kozinets, 2019; Lynch, 2015).

In the following section, we will discuss two ways in which nutritional practitioners can capitalize on social-media discussions.

Practitioners can visit these sites and provide informed, evidence-based nutrition information

Our findings suggest that social media present a potentially important platform for nutrition influence, including for practitioners to provide nutritional advice and education. Social-media discussion participants were open to suggestion, especially when deliberately seeking information on fresh fruit and vegetables.

We noted how Ottawa residents seeking food-shopping information on social media were thankful and reported using the information and suggestions provided by other participants. This suggests a level of trust in the information shared in social-media discussions and the possibility of establishing a reciprocal information exchange.

However, if social media are to be incorporated into nutrition practices, to be viewed as authentic, it is crucial that practitioners are familiar with social media, are able to write in lay terminology and can support their advice with personal anecdotes (Gruzd, Lannigan and Quigley, 2018; Record et al., 2018). Practitioners could also consider partnering with researchers, trainees or community members more familiar with social media. In our study, for example, we noted how encouraging a vegetarian diet appeared to be an acceptable suggestion when framed as a cost-saving exercise, as opposed to a health or ethical issue, particularly when accompanied by a personal anecdote.

Consequently, nutrition practitioners could consider visiting social-media discussions to provide informed, educated and evidence-based advice. This type of communication through social media may help to spread health knowledge in an evidence-based manner, so that people seeking advice online are not receiving incorrect information (Steffens et al., 2019; Thackeray et al., 2012). Using social media to disseminate information and advice may improve nutrition literacy and ultimately encourage healthier eating practices.

Practitioners can visit social-media sites to learn about the public's views on nutrition-related programmes and policies

In our search, we discovered a discussion that was specifically focused on the public health unit's retail food-environment programme. We also located a number of discussions focused on the general topic of increased access to fresh fruit and vegetables, which provided valuable insights into what Ottawa residents thought of the initiative and what they deemed important in this regard.

Because of the spontaneous nature of the discussions, once a programme, service or policy has been developed and implemented, nutrition practitioners can search for related social-media discussions, giving them access to timely opinions that have not been influenced by a researcher (Gregg et al., 2017; Kozinets, 2019). Discussions can reveal unexpected perspectives, such as insights into social norms that are not accessible through other methods. For example, we identified a number of perspectives on convenience stores, such as the "common sense" notion that such stores would only sell low-quality foods at high prices. These findings supported previous work that concluded that unique perspectives can be revealed by seeking out the voices of people through channels other than traditional approaches, such as surveys and interviews (Rowbotham et al., 2019).

Our findings further suggested that at least some Ottawa residents wanted the public health unit to provide more information about its nutrition-related activities online – a finding that echoed the public health unit's findings from interviews with store owners, who valued a greater social-media presence. We recommend that practitioners consider using social media to communicate with the public and respond to posted questions and comments about their programmes and policies. Harnessing social media in this way offers practitioners another way to engage with the public during programme and policy development and evaluation (Nik-Bakht and El-Diraby, 2015; Thackeray et al., 2012).

CONCLUSION

In our exploratory study of social-media discussions on food shopping in Ottawa, we noted limitations common to social media: we could not verify participants' specific demographic information and we were unable to ask follow-up questions for clarification. However, these limitations can be lessened by combining social media with traditional methods to develop a more well-rounded understanding (Kozinets, 2019). We encourage researchers to conduct such needed social-media research, including further analyses of social-media participants.

Our key finding was that, despite the limitations of the data, we would recommend social-media discussions for two different purposes. First, our findings suggest that practitioners could consider visiting social-media sites to provide information and respond to nutritional concerns. This has the potential to improve nutrition literacy, possibly more than through traditional channels, as participants appear to be to open to advice shared in such discussions. Second, by analysing the publicly posted discussions on people's experience with their food environments, social-media discussion analysis can be harnessed to learn about social norms and include a greater diversity of perspectives when designing and evaluating nutrition programmes and policies.

Consequently, we echo the recommendation that further research is needed to understand the social-media usage of different population groups based on such characteristics as socioeconomic status, geographical location, ethnic background and gender (Granheim, 2019). Even so, we encourage nutrition practitioners to consider social-media discussion analysis as another tool among many that can be used to improve nutrition-related activities, nutrition literacy and food environments.

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eLearning to empower front-line nutrition workers in India

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ABSTRACT

In February 2019, the FaNS Project and the Department of Women and Child Development of Madhya Pradesh, India, implemented an interactive eLearning platform to provide high-quality, systematic and standardized training to boost the nutrition knowledge and counselling skills of 97 135 front-line workers and supervisors. To date, 25 000 have embarked on the 40-hour training course and 7 000 have completed it. A study was conducted in December 2019 to analyse the effects of this digital tool on the capacity-building of front-line workers, using a quasi-experimental study. The sample comprised 205 front-line *Anganwadi*[1] workers and their supervisors. Ninety-nine percent of participants claimed to have benefited from the training and said that it had enhanced their nutrition knowledge and counselling skills. The course was said to be comprehensive, systematic and suited to participants' roles and responsibilities. Recommendations from the study included the need to address implementation challenges, such as platform accessibility and communication gaps in orientation and technical support.

INTRODUCTION AND BACKGROUND

The state of Madhya Pradesh is located in Central India, with nearly 75 million inhabitants and a sizeable population of Scheduled Castes and Tribes (Ministry of Social Justice and Empowerment (2017). Seventy-two percent of the population is rural (Office of the Registrar General & Census Commissioner, India, 2011). According to India's Comprehensive National Nutrition Survey (2016–18), 39.5 percent of children under the aged of five in Madhya Pradesh are stunted and 19.6 percent are wasted (Ministry of Health and Family Welfare and IIPS, 2017). The Gesellschaft für Internationale Zusammenarbeit's (GIZ) Food and Nutrition Security, Enhanced Resilience (FaNS) project in India is part of the German Federal Ministry for Economic Cooperation and Development's (BMZ) global "One World – No Hunger" special initiative (GIZ, n.d.; BMZ, 2018). FaNS aims to improve the food and nutritional situation of 144 000 women of reproductive age and 30 000 small children (aged 6–23 months) in two of the state's districts.

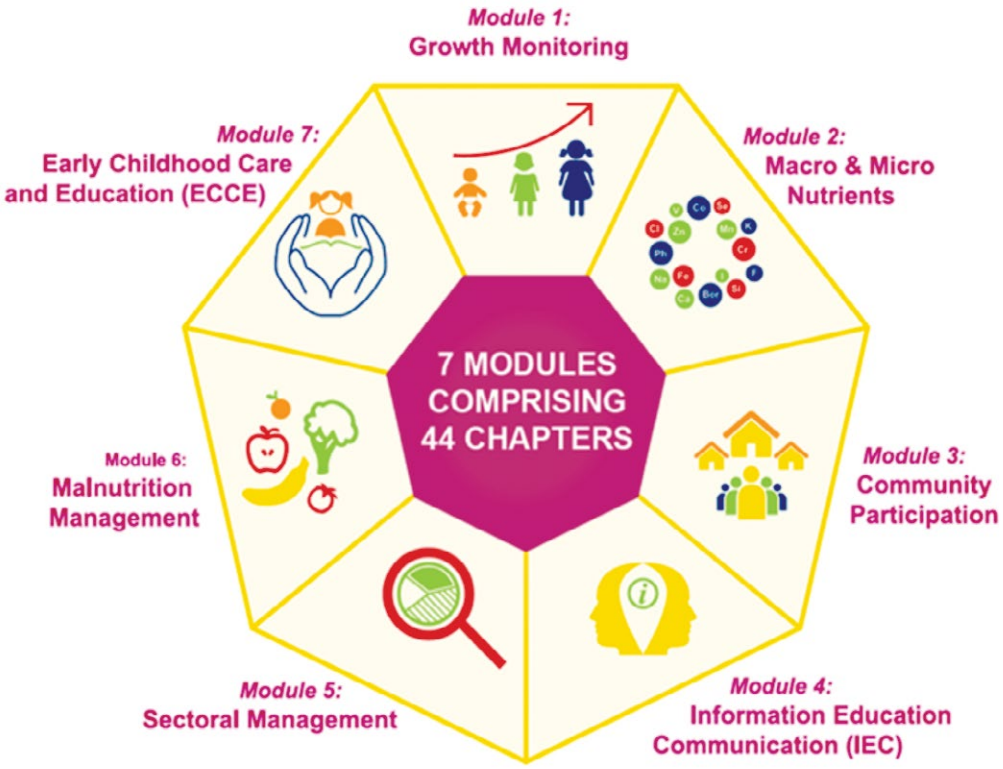
Anganwadi workers (AWWs) – more than 97 000 female front-line staff of the State Department of Women and Child Development (DWCD) across Madhya Pradesh – play a key role in reaching out to women in villages, transferring

1 An *Anganwadi* (meaning "courtyard shelter") is a type of rural women and child-care centre established by the Indian government in 1975 as part of a programme to combat child hunger and malnutrition.

nutrition knowledge and encouraging behavioural change to good nutrition and hygiene practices. They are recruited directly from villages by DWCD. However, AWWs often have knowledge gaps on nutritional topics, such as complementary feeding or malnutrition management, and lack counselling skills. The DWCD gives them an initial, 26-day residential induction course at training centres when they start, with refresher training sessions every two years. In these traditional classroom settings, they learn about their roles and responsibilities, as well as woman and child health/nutrition entitlements under existing policies and schemes. AWWs are responsible for the health/nutrition of women and children, for example, by providing hot, cooked meals for preschool children aged 3–6 years at local *Anganwadi* centres, monitoring children's growth, conducting home visits to counsel or to provide take-home rations for pregnant women and children under three years of age. With so many daily duties, they lack access to structured and standardized (further) training possibilities, especially in remote locations. Furthermore, their educational levels vary, from primary schooling to graduate education. High-quality, standardized, in-depth training is lacking.

To fill this gap, the FaNS project, together with the DWCD in Madhya Pradesh, developed an interactive eLearning training platform, called *Anganwadi Shiksha*, to systematically build the capacity of the state's AWWs. *Anganwadi Shiksha* consists of structured, self-paced learning content in seven modules, divided into 44 chapters. The content is a compressed version of the DWCD's extensive classroom training. Topics include growth monitoring, macro- and micronutrients, malnutrition management, information education and communication (IEC), early childhood care and education, community participation and sectoral management (for supervisors) (Figure 1). Counselling skills are integrated into all topics. The eLearning course has engaging visuals, quizzes and narrations in a simple form of Hindi. The animated visuals are culturally appropriate in terms of local-community scenes, AWW dress code, local dialect, food groups and cuisines. Even illiterate AWWs can complete the course, as it is completely audio-visual. The software is open source, with 40 hours of learning and certification by the DWCD upon course completion.

Figure 1. STRUCTURE OF THE ANGANWADI SHIKSHA eLEARNING COURSE



Source: *FaNS Project (2017)*

The platform has been integrated into the state DWCD management information system (MIS) to ensure institutionalization and ownership by the Department. This also offers the opportunity to track the learning status of the AWWs enrolled across the state through a live dashboard. The MIS is accessed monthly by the AWWs and more than 3500 supervisors through computers, tablets or smartphones.

The rollout of Anganwadi Shiksha across Madhya Pradesh began in February 2019. In collaboration with the DWCD, the FaNS project undertook an orientation course in April and May 2019 for supervisors and their district-level line managers to ensure widespread enrolment. As of January 2020, 25 000 AWWs and supervisors had started the course and 7 000 had completed it. The DWCD has made the training mandatory for AWWs. *Anganwadi Shiksha* could benefit more than 97 000 AWWs in Madhya Pradesh and has the potential to reach 1.4 million AWWs in other states across India.

Over the past two decades, web-based learning interventions have shown positive results in enhancing workers´ knowledge, improving communication skills, decreasing the workload of health staff and enhancing workers' ability to manage and recall records (Sukums et al., 2014; Borkum et al., 2015; Bondale et al., 2013; Hong et al., 2011; Khatony et al., 2009; Darbyshire, 2004). There has been a rise in the number of digital interfaces and platforms for assistance, but there are few studies evaluating their performance and how users perceive them.

Consequently, a quasi-experimental study of *Anganwadi Shiksha* was conducted in December 2019 to analyse the platform's ease of use, its boost to knowledge and the improvement in counselling on nutrition-relevant topics. The study also aimed to document challenges to the rollout and long-term implementation of the platform in the state and to provide recommendations for improvement.

METHODOLOGY

A mixed-method study was used to collect data in two districts of Madhya Pradesh (Hoshangabad and Shivpuri). The participants were 105 AWWs who had completed the eLearning training modules (intervention group) and 100 AWWs who had not been exposed to eLearning platform at the time of data collection (control group). The chosen districts were suggested by the DWCD and were comparable in terms of population characteristics. A random sampling was undertaken in Excel, using the list of AWWs from the DWCD dashboard, in which every third name was selected for the intervention or control groups.

Tools used to collect the data included:

- **Quantitative questionnaires** (n=105 intervention, n=100 control), with themes to capture information on: sociodemographic information, training needs, ease of use and relevance of the eLearning platform, challenges, achievement of the intended objective, (retention of) knowledge, counselling skills, etc.
- **in-depth interviews** with nine supervisors and two district-level officials (n=11) to understand perceptions and challenges and the facilitator´s role in the implementation and scale-up of Anganwadi Shiksha
- **focus-group discussions** (FGDs) (n=6), comprising 6 8 AWWs each, to gain in-depth insights into their perceptions, problems and views on usefulness and gains in terms of knowledge and skills.

The quantitative questionnaire was pre-tested and the research team was trained. The questionnaire was developed in English and translated into Hindi, then translated back into English to ensure reliability. Discussions were held with data collectors to check translated meanings. Informed written consent for audio recording was obtained from all participants.

For the quantitative analysis, the data were entered and analysed in IBM SPSS Statistics version 24. Descriptive frequencies and group comparisons were carried out between the intervention and control groups. Chi-square and t-tests were performed for key statistics. The qualitative data were analysed using qualitative content analysis; the researchers then refined this data manually. The audios of interviews were transcribed and translated from Hindi to English, then entered manually.

RESULTS

Sociodemographic data of Anganwadi workers

The age of the 205 AWWs ranged from 23 to 61 years. On average, they had been working with the DWCD for around 12 years at the time of the study, both in the intervention and the control groups. Most participants belonged to socially disadvantaged populations, as defined by the Government of India, namely, Scheduled Castes or Tribes (Ministry of Social Justice and Empowerment, 2017). In terms of educational qualifications, 68 percent of intervention-group participants and 42 percent of control-group participants were graduates (mainly of the social sciences). Only 11 percent of the control group and 8 percent of the intervention group were educated up to eighth class (the last class before high school), while 18 percent and 3 percent, respectively, had schooling to less than eighth class (Table 1).

Table 1. SOCIODEMOGRAPHIC BREAKDOWN OF FRONT-LINE WORKERS

Variable	Intervention group (%) (n=105)	Control group (%) (n=100)
Age (average, years)	40	40
Length of service (average, years)	12.3 ± std. dev. 6.4	12.4 ± std. dev. 6.4
Educational qualification (university graduate)	67.6%	42.0%
Social category (Scheduled Caste (SC), Scheduled Tribe (ST) and Other Backward Castes (OBC), per the Government of India classification (Ministry of Social Justice and Empowerment, 2017)	OBC = 47.6% SC and ST= 16.2%	OBC = 36% SC and ST= 19%

Awareness of roles and responsibilities and reported training needs

The eLearning platform helped intervention-group participants acquire increased knowledge on key issues. Completion of the course led to far better awareness of roles and responsibilities in certain areas, such as counselling on breastfeeding (p value: 0.034) and community participation (p value: 0.022) (Table 2).

Among control-group participants, as expected, reported training needs were high: 72 percent reported facing difficulties in performing their job in the field and 97 percent said they would be better equipped in the field if they received more knowledge of nutritional management and enhanced counselling skills.

Table 2. LEVEL OF AWARENESS OF ROLES AND RESPONSIBILITIES

Variables	Group	Mean ± std. dev. (SD)	t	Sig (p value)
Providing health & nutrition education for women and children	Intervention	3.5 SD 0.60	0.266	0.221
	Control	3.5 SD 0.67		
Counselling on breastfeeding	Intervention	3.9 SD 0.35	1.017	0.034
	Control	3.80 SD 0.44		
Home visits	Intervention	3.77 SD 0.44	0.484	0.312
	Control	3.74 SD 0.48		
Encouraging community participation	Intervention	3.67 SD 0.49	1.012	0.022
	Control	3.60 SD 0.58		

Perceived effects of the eLearning course

Content, language and visuals

Most AWWs and their supervisors agreed that the content of the eLearning platform was comprehensive, systematic and in line with their roles and responsibilities. Sixty-four percent said the information provided on the platform went into greater detail than classroom training. Ninety-two percent of the participants said the content was easily understood and 99 percent said the language was comprehensible. Ninety-eight percent of the intervention group said the videos and graphics were locally apt, culturally appropriate and relatable. According to one focus-group participant:

> *"I felt good when I took the training. I felt that I have understood everything, and I have gained good amount of experience about what I am supposed to do, that in the morning which house am I supposed to visit. Basically, I also understood what kind of counselling should be given to women."*
> (AWW, Hoshangabad district)

Enhancement of knowledge and counselling skills through eLearning

More than 65 percent of AWWs reported that they had acquired nutrition knowledge and counselling skills in all key areas, such as effectively delivering messages on infant and young child feeding practices, nutritious and diverse food preparation and hygiene practices, growth monitoring, behavioural change at household level, and strategies and techniques to mobilize community participation (Table 3). They also said they had acquired soft skills, such as the effective use of IEC materials, asking open-ended questions, greeting family, empathy for mothers in different contexts, etc. These skills are the primary responsibilities of AWWs. Overall, the participants rated the eLearning training very highly, with 42 percent ranking it as "good" and 53 percent declaring it "excellent".

Table 3. COUNSELLING SKILLS ACQUIRED BY SAMPLE-GROUP PARTICIPANTS

Skill	n	Level acquired	% (n)
Effectively deliver messages on early initiation of breastfeeding during home visit	102	Little to none	10.78 (n=11)
		Moderate	21.56 (n=22)
		Sufficient and significant	67.64 (n=69)
Effectively deliver messages for social behaviour change communication	102	Little to none	7.84 (n=8)
		Moderate	13.72 (n=14)
		Sufficient and significant	78.42 (n=80)
Mobilize community participation to create awareness of the importance of nutrition-related schemes	100	Little to none	8 (n=8)
		Moderate	17 (n=17)
		Sufficient and significant	75 (n=75)
Give oral presentations confidently and convincingly to mothers about Integrated Child Development Services programme benefits	100	Little to none	7 (n=7)
		Moderate	13 (n=13)
		Sufficient and significant	80 (n=80)

Most of the AWWs and supervisors said the eLearning content enhanced their skills, especially with regard to growth monitoring and plotting. In a focus-group discussion, several participants noted that the practical demonstrations of height and weight measurements in course videos were very informative and had increased their knowledge.

> "*I did the first module on growth monitoring and, in that, I could revise several topics. Generally, we leave some sections/ topics, or we don't remember them, but these modules allowed us to revise our knowledge from the beginning.*"
> (Focus-group discussion participant, Hoshangabad)

The participants found the IEC module quite useful in building their counselling skills. They agreed that such modules enhanced their personality and gave them the necessary skills to talk confidently with beneficiaries.

In the control group, several gaps were identified in terms of knowledge and counselling skills. Control-group participants cited knowledge and skills deficits when it came to micro- and macronutrients, counselling techniques using different IEC tools – only 43 percent and 56 percent reported having sufficient knowledge, respectively. Intervention-group participants suggested that topics such as the health management of adolescent girls and the counselling of men and women in the family, especially with regard to nutrition rehabilitation-centre admissions for malnourished children and the appropriate way of using a standometer and pedometer, should be included on the eLearning training platform.

User-friendliness of the eLearning platform

Most intervention-group participants described progression from one module to another, the Hindi voice-over and the login system as user-friendly, though 42 percent reported difficulties with login.

After completing each module, the AWWs answered questions to assess their learning. The respondents felt this was a useful feature. One AWW said it helped her to identify topics where she needed to boost her knowledge or revise:

> *"Because I liked solving the questions in the modules and in case my answers were wrong, I could realize where all I was making mistakes and it made us aware about our weakness."* (Anganwadi worker, Hoshangabad)

In terms of mobile-phone use generally, it was found that 98 percent of the intervention group and 95 percent of the control group could use some, most or all functions. Only 2 percent of the intervention group and 5 percent of the control group could not use the phone by themselves. However, front-line workers in the intervention group reported seeking help from a family member to access the platform and learn from it. The eLearning platform was reported to be easy to manoeuvre for most of the intervention-group AWWs and their supervisors in Shivpuri district during focus-group discussions, as they had been working with mobile technology for the previous two years. The government had also given them a month-long general computer training course. However, their familiarity with the features of the eLearning system was limited to modules and assessment questions, so further reinforcement on the platform is needed to ensure the AWWs retain the content.

Issues with implementation

The supervisors mentioned that orientation on the eLearning programme was provided to them just once in April/May 2019 and that an intensive orientation programme would have helped them to become more familiar with the platform. Furthermore, the central government held a seven-hour classroom refresher course for AWWs and their supervisors during data collection. They compared this monthly course with the one-day eLearning orientation that had taken place in April/May 2019 and found the monthly hand-holding support to be more helpful. Moreover, a local training agency had been hired by the DWCD to conduct the district-level eLearning orientation across Madhya Pradesh in April/May 2019, but the study participants did not perceive this local agency to be conducting the orientation on its behalf.

Sixty-two percent of the intervention group and 69 percent of control-group participants reported good network connectivity at their place of residence. Sixteen percent of the intervention group and 7 percent of the control group said there was no internet connectivity at the local health centre. Apparently, it was not communicated effectively that the eLearning training was available offline. Many participants reported having experienced technical difficulties, ranging from problems with sound and video and internet connectivity to a few incorrect answers to the questions (due to a technical error, resolved after pilot-testing). Most AWWs and their supervisors were not aware of the feedback feature in the platform to give their suggestions for improvements.

Five percent of the intervention group and 8 percent of control-group participants did not possess a smartphone. Intervention-group participants who did not have a smartphone completed the programme using the mobile phone of a relative or front-line co-worker.

Furthermore, there was an assumption among intervention-group participants that they had a limited time in which to complete modules and assessment questions, highlighting the need for better communication with participants.

Preference for eLearning over classroom training

Sixty-five percent of participants said it took them less effort to learn using the eLearning platform, while 61 percent said they acquired more knowledge and skills than in other training programmes. Sixty-five percent of participants said they preferred eLearning to other modes of training.

Seventy-two percent of control-group participants said the eLearning platform would be more convenient and useful for front-line workers. Sixty percent of the control group considered it to be greatly beneficial and 14 percent said it was beneficial to some extent. Ninety-two percent of control-group participants expressed interest in undergoing the eLearning training. The remaining 8 percent of control-group participants considered existing training programmes sufficient and were not confident about training through eLearning.

DISCUSSION AND CONCLUSION

The purpose of the eLearning training platform is to offer AWWs and their supervisors standardized training to enhance their counselling skills, so as to promote good nutrition practices among mothers, not to replace classroom training.

The study showed that the eLearning course could fill a capacity-building gap and enhance the knowledge and skills of front-line workers, as the content and language were found to be comprehensive, systematic and beneficial to participants, helping them to fulfil their roles and responsibilities at village level. The content of the eLearning training was appreciated by the learners, as it was visual and local-scenario based. The information provided on the eLearning platform was deemed to be more detailed than that received in classroom training. It can be easily used to enhance both the knowledge and skills of front-line workers.

In terms of challenges to rollout and long-term implementation, the study's findings indicate that there is still a need to systematically address implementation gaps, especially communication at the last mile. For instance, the eLearning platform has a live dashboard with a feedback mechanism, but it needs to be better promoted and used. Logistical implementation challenges need to be discussed with the DWCD for a smooth scale-up. This includes internet connectivity and the availability of smartphones for AWWs from the government. It is also important to address the motivational role of supervisors in supporting AWWs to use the platform and disseminate the correct information. For instance, there was an instance of incorrect information is being circulated by supervisors to motivate AWWs to register and complete the eLearning course within a given period of time.

So far, a local training agency has organized one orientation programme in each of the 52 districts of Madhya Pradesh on behalf of the DWCD. Even though these courses were conducted on government premises (which provided the necessary infrastructure, such as computers and internet connectivity), supervisors said the orientation infrastructure did not sufficiently meet training requirements. It is, therefore, recommended that further orientation courses be conducted for supervisors and that a user-friendly manual be provided to encourage efficient use of the eLearning platform. Another important lesson for eLearning training was that orientation programmes should be carried out more frequently, directly by government officials and in a coordinated way to avoid duplication of effort and confusion.

While digital technology continues to gain momentum, there are challenges that still need to be addressed. This applies, too, to the eLearning platform for AWWs and their supervisors.

The findings of this study suggest that the platform has excellent potential for upscaling to meet the training needs of front-line workers across India. It provides an opportunity to train front-line workers with a minimum of resource mobilization and to ensure quality training through a medium that front-line workers find interesting. Useful next steps could include the creation of a knowledge-sharing system and improvements to the grievance-redressal mechanism for front-line workers and their supervisors. A further study on operational feasibility would support the upscaling of the eLearning platform.

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RAVI GOYAL/LOCAL NGO/GIZ

Digital solutions for nutrition-sensitive SME transformation

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ABSTRACT

The world is facing complex nutrition problems that are largely caused by unhealthy diets. As dietary quality is fundamentally shaped by food systems, in which small and medium enterprises (SMEs) play a key role, engaging SMEs is crucial to transforming food systems so that they deliver sustainable, healthy diets for all. Digitalization may have a huge impact on food systems, but SMEs still have to fully capitalize on digital technologies. FAO has conducted research by way of multi-stakeholder workshops and surveys in a number of low- and middle-income countries (LMICs) to identify the hurdles to SMEs making nutrition a major consideration of their operations.

We found a variety of common challenges. In this paper, we look at a number of these (limited policy support, limited access to finance, difficulty in getting supplies, technical and knowledge gaps, and low consumer awareness of healthy diets and nutrition) and discuss how digital technologies can address them. We propose innovative solutions, including specific technologies (such as smart, blockchain-based supply chains, digital microfinance, eLearning and social-media marketing) and organizational forums (such as digital incubators, accelerators and innovation labs).

INTRODUCTION

The global nutrition challenge and the role of SMEs

The world is facing complex nutrition challenges. The multiple forms of malnutrition – undernutrition, micronutrient deficiency, overweight, obesity and diet-related noncommunicable diseases (NCDs) – exist everywhere and can even coexist within the same country, household or individual (WHO, 2017). Globally, more than 2 billion people are affected by one or more micronutrient deficiencies, while more than 200 million children are stunted or wasted; at the same time, 1.9 billion people are overweight or obese (Committee on World Food Security, 2016). Malnutrition comes at an enormous human, social and economic cost: an estimated at USD 3.5 trillion is lost worldwide each year in terms of productivity, health and well-being, cognitive ability and fulfilment of human potential (Committee on World Food Security, 2016).

Diet is critical to a population's nutritional status and there is unequivocal evidence that the global malnutrition pandemic is mostly caused by poor diet (GBD 2017 Diet Collaborators, 2019). Diets in many parts of the world are high in unhealthy foods, such as ultra-processed foods rich in sugar, salt and calories, and low in nutritious foods, such as nuts, fruits, vegetables and legumes (Willett et al., 2019). Such trends are driven in part by rapid urbanization, increasing incomes and inadequate access to nutritious foods. What's more, food production is pushing the Earth's environmental systems beyond safe boundaries (Willett et al., 2019). Faced with these unprecedented challenges, food systems around the world are in dire need of fundamental transformation.

Consumers' dietary quality is essentially shaped by the food system they are in, which includes all of the elements and activities relating to the production, processing, distribution, preparation and consumption of food and the outputs of these activities (HLPE, 2017). These can be organized into three constituent entry and exit points for nutrition: food supply chains, food environments and consumer behaviour (Box 1). The private sector is deeply involved in all of them, thus determining the dietary quality of its consumers.

Small and medium-sized enterprises (SMEs)[1] produce most of the food consumed worldwide. Depending on food in question, small and medium-sized farms of less than 20 hectares (ha) produce between 30 percent and 65 percent (by volume) of global output for human consumption (Demmler, 2020). Among the major food groups, with the exception of sugar crops, oil crops and livestock, small and medium-sized farms produce the majority of them: cereals, fruits, pulses, roots and tubers, and vegetables (Herrero et al., 2017). SMEs are important at each stage of the food value chain. The role of SMEs in food processing is dependent on the commodity and type of processing. At the retail stage, however, 70 percent to 100 percent of foods are sold through SME channels (Demmler, 2020). Consequently, SMEs have a key role to play in transforming food systems so that they deliver sustainable healthy diets for all (FAO, 2018).

Box 1. DEFINITIONS OF FOOD SUPPLY CHAIN, FOOD ENVIRONMENT AND CONSUMER BEHAVIOUR

The **food supply chain** encompasses all activities that move food from production to consumption, including production, storage, distribution, processing, packaging, retailing and marketing.

The **food environment** refers to the physical, economic, political and sociocultural context in which consumers engage with the food system to acquire, prepare and consume food. The food environment consists of: "food entry points", in other words, the physical spaces where food is obtained; the built environment that allows consumers to access these spaces; personal determinants of food choices (including income, education, values, skills, etc.); and the political, social and cultural norms that underlie these interactions.

Consumer behaviour reflects the choices made by consumers, at household or individual level, on what food to acquire, store, prepare and eat, and on the allocation of food within the household (including gender repartition and the feeding of children). Consumer behaviour is influenced by personal preference, determined by taste, convenience, culture and other factors. However, consumer behaviour is also shaped by the existing food environment.

Source: *HLPE (2017)*

The potential of SMEs to contribute to food-system transformation

SMEs, particularly in LMICs, have great potential to address the food-system situation, particularly through the food environment, as they are:

- closely linked to producers
- familiar with local consumer tastes and preferences
- engines of rural transformation through job generation
- drivers of innovation that are located close to rural areas (FAO, 2018).

However, they also face steep hurdles when it comes to adopting nutrition as one of their major operational considerations. Through its project "Strengthening capacities for nutrition-sensitive food systems through a multi-stakeholder approach (involving private sector, civil society organizations and academia)", FAO conducted background research for Ghana, Kenya and Viet Nam in order to understand these hurdles. It conducted surveys and interviews at SMEs producing nutritious foods in those countries and held global and national multi-stakeholder workshops for managers of SMEs, producers' associations, government officials, development agencies and academic institutions. The three countries were found to have the following issues in common, confirmed by SME owners and business associations at recent workshops:

- a lack of basic infrastructure (electricity, water, information and communication technology, internet services, storage facilities, etc.)
- limited policy support (such as the absence of a single overall strategy for the agro-processing sector) and excessive taxation
- limited access to finance to start, expand and upgrade businesses due to complicated procedures and requirements
- limited adoption of technology
- shortfalls in the timely and consistent supply of raw materials in the required quantity and quality
- poor business skills, limited marketing capacity and an absence of consumer linkages

1 In this paper, we use the OECD definition of SMEs (OECD, 2005): SMEs are non-subsidiary, independent firms that employ fewer than a given number of employees. This number varies across countries. The most frequent upper limit designating an SME is 250 employees, as in the European Union. The authors would like to underline that food-sector SMEs exist in a variety of other forms, such as community-based enterprises and farmer associations. Small and medium-sized farms are also considered SMEs in this context.

- gaps in technical and managerial knowledge and capacity related to product development, quality assurance and market intelligence, all of which are necessary to align products with market needs and to meet food-safety requirements
- among SMEs, a lack of nutrition awareness and technical know-how to build businesses based on nutrition
- low consumer awareness of healthy diets and nutrition.

A number of these are potential entry points for digital technologies.

The influence of digital technologies on the agrifood industry

Achieving the Sustainable Development Goals, which include clear targets on nutrition, by 2030 will require more productive, efficient, sustainable, inclusive, transparent and resilient food systems (FAO, 2017). Innovation and digital technologies could be part of the solution.

Digital technologies, services, products and skills are transforming modern economies and entire systems of production, management and governance (Brennen & Kreiss, 2014). The possibilities of such technologies will multiply with breakthroughs such as blockchain, artificial intelligence (AI), robotics, the Internet of Things, 3D printing, immersive reality and quantum computing, fuelled by lower cost and a greater ability to generate, collect and analyse data. While improvements in IT infrastructure in rural areas will take time, their potential impact on food systems is likely to be huge. Digital technologies can play an important role in helping to optimize agriculture, food and nutrition infrastructure to support abundant harvests, improve logistics and distribution networks, reduce food and nutrient loss and enable greater global food security now and into the future (FAO, 2020).

Digitalization creates the potential for the application of digital technologies to all steps in the food supply chain. This presents great opportunities for SMEs in the agrifood sector to enhance their overall capacity, leading to the supply of better-quality diets for consumers.

The digitalization of the agrifood industry is leading to an increasingly automated and informatized process of food production and commercialization. This environment may, in turn, lead to the delocalization of food products, as it allows SMEs to gain direct access to and to penetrate local and international markets. It starts at the level of agricultural inputs, with seeds and other plant genetic material being transformed into digitized sets of information that allow farmers to select the best seeds and cultivate them under optimized conditions. It also applies to food consumers, now the subjects of food corporations' data-gathering mechanisms, which use algorithms to categorize them and generate personalized food offers for them. The criteria currently being applied have little to do with preventing diet-related NCDs, but focus heavily on profit generation. However, these powerful tools could be used to advance nutrition-sensitive agricultural production and consumption. It should be emphasized that in the trend of digital transformation, smallholder farmers' rights such as retaining locally produced seeds and independent decision-making in production need to be guaranteed.

How digital technologies can help SMEs to adopt a nutrition-sensitive approach

Before we look at solutions, it is helpful to describe the landscape of digital technologies in the agrifood system. Some of the information in this section has wide-reaching implications for society as a whole, while some is directly applicable to SMEs involved in food systems.

The availability of agrifood system-focused digital technologies has been increasing and workers need to understand them to apply them (Trendov et al., 2019). A shortage of workers skilled in digital technologies is a major challenge for agrifood SMEs, especially those in rural areas. IT professionals often seek higher wages than rural agrifood businesses can afford, resulting in limited local technical support. As a result, the introduction of digital technologies in the agrifood sector in LMICs is lagging that in other sectors.

In addition, with the average size of farms relatively small and arable land divided into small parcels, the introduction of technologies becomes more difficult and requires special solutions (Vasa et al., 2018). Major indicators of digital technology penetration, such as cellular subscriptions, mobile broadband subscriptions and rural internet access rates, have been rising significantly in LMICs, most notably in Asia and the Pacific and Africa (Trendov et al., 2019). However, the gaps between urban and rural areas, and regions and economies, are huge. About 3.8 billion people remain offline, disproportionately in rural and remote areas (GSMA, 2018).

Although mobile phone and mobile broadband prices have been declining overall in recent years, the affordability of

information and communications technology (ICT) services is still a key barrier to uptake and a challenge in LMICs. Affordability is the main barrier to smartphone ownership, with a basic mobile broadband plan costing more than 60 percent of annual gross national income per capita, on average (ITU, 2017).

Still, digital technologies can offer effective solutions to some of the challenges faced by agrifood businesses, in particular, limited policy support, limited access to finance, difficulty in getting consistent supply of raw materials, gaps in technical and managerial knowledge and capacity, and low consumer awareness of healthy diets and nutrition. There are opportunities to contribute to nutrition when addressing these challenges and, here, we discuss some potential measures.

Limited policy support

Policy frameworks and standards for digital agriculture are the supporting mechanisms for incorporating the potential of digitalization into agriculture and preventing a digital divide. The main challenges are policymakers' inability or reluctance to adopt standards, a lack of potential for development digital products and services, and a lack of digital infrastructure. Some policy instruments addressing the digital economy are fairly broad in scope, but do not include digital agriculture as a means of improving the general outlook. Similarly, there are policies on technological development that are of value to both rural and urban areas, but the focus is on the technology, rather than agrifood and rural improvement.

To digitalize our food systems, combining organizational, regulatory and technological solutions is key. The smart use of digital technologies along the food supply chain creates opportunities to spur the adoption of common digital standards and principles, supply-chain transparency and real-time information-sharing practices.

Limited access to finance

In ordinary financial systems, it may be difficult for SMEs to access the credit that is essential to operations and expansion. Digital microfinance can help to establish a link between local sources of production credit (and other lending) and SMEs. Good practices of digital microfinance in African countries have been summarized in a report by the Alliance for Financial Inclusion (2018). Its case studies show that affordable, fully mobile, cloud-based banking can help digitalize the services and processes of microfinance providers, increasing the lenders' capacity to serve clients, including SMEs. The report also explores the risks and challenges of digitalized microfinance. In Ghana, the AgroTech Smartex mobile application – designed and implemented by the Grameen Foundation – aims to strengthen linkages between farmers, input suppliers and agrifood SMEs, but also facilitates access to credit through better record keeping and monitoring (Agyekumhene, et al., 2018).

To contribute to a nutrition-sensitive food system, the implementation strategies of investment and financing projects need to recognize the link between the microfinance and nutrition outcomes (Babu, 2019). Microfinance processes could be designed in such a way as to offer specific incentives to SMEs producing healthy and nutritious foods.

Difficulty in getting consistent raw-material supplies

SMEs have limited purchasing power and weak capacity to check the quality of raw materials, so may be vulnerable to the seasonality of material supply and low-quality materials. Here, technologies such as blockchain, AI and machine learning can be of great help.

Blockchain not only allows a product to be traced back to each point in the agrifood value chain but can show how it was handled — if common standards, policies and principles are adopted by all stakeholders in the value chain. Blockchain could fundamentally change SMEs' trading practices and reduce, modify or entirely eliminate the need for intermediary services along the agrifood value chain. It holds particular potential for LMICs and it is already being used to tackle market failures and empower smallholder farmers. In rural areas, blockchain solutions can be used to increase SME access to markets and financial services by building their business reputation in the food system. The tracking power of blockchain can also help companies to meet food-safety requirements.

While blockchain can be used to track the nutritional quality of foods along supply chains, the information being tracked needs to be collected first. The nutrient contents need to be assessed at each major step of the chain before blockchain can step in to keep a record. Technical capacities, regulatory and policy frameworks and verification mechanisms need to be established in this regard.

One example of the use of blockchain technology to improve the agrifood value chain is a pilot project launched by the World Wildlife Foundation (WWF) in 2018. Its goal was to create a transparent and traceable supply chain in Fiji's tuna sector (Cook, 2018). The pilot used a combination of radio-frequency identification (RFID) and Quick Response (QR) codes to capture information throughout the supply chain and registered this automatically with various devices positioned throughout the value chain (vessel, dock, processing facility). At the packaging stage, the tag was replaced by a QR code to identify the product. Consumers' growing demand for information is expected to provide an incentive for actors in the value chain to adopt more sustainable fishing practices. Other examples can be found in Blaha and Katafono's (2020) detailed analysis of the application of blockchain in seafood value chains.

In addition, AI and machine learning present an opportunity to conduct in-depth analysis of growing, manufacturing, distribution and consumption data, as well as consumers' interest in healthy foods, for intelligent forecasts and recommendations for food-industry stakeholders. Building an AI platform will not only help to understand supply and demand, but also help stakeholders to adapt to changing population needs and wants. One example is Gastrograph AI,[2] a machine-learning and AI platform for modelling human sensory perception and predicting consumer preferences for food and beverage products. While the technology, aiming at elucidating flavours and smells, is not specifically designed to improve nutrition, it could be used by food manufacturers to make healthy foods more palatable and, thus, more widely accepted.

Gaps in technical and managerial knowledge and capacity

Inadequate education and capacity-building impede the knowledge needed for digital agriculture and market competitiveness, resulting in the low adoption and use of advanced technologies. Meanwhile, limited access to skill development opportunities, information and open data is hampering the development of agricultural entrepreneurship and a sustainable digital ecosystem. A lack of localized content for new digital services is also a shortfall. Even if other divides are overcome, there is still a gap in access to local information and services that can help to increase use of these technologies.

Digital incubators, accelerators and labs are some of the models that must be promoted to support digital skills and inspire agricultural entrepreneurship. Good examples include EIT Food,[3] a pan-European consortium that focuses on entrepreneurship and innovation in the food sector, and the European Union-funded "Smart Agri Hub" project,[4] which aims to support digital innovation start-ups in the agrifood sector. In collaboration with partners, FAO has organized a number of hackathons and accelerators in Rwanda and other African countries (FAO, 2018) and developed proposals to establish digital hubs across Africa.

In addition, eLearning courses, especially those specifically tailored to SMEs, can be great tools for capacity-building. Including practical content on nutrition, food processing and food safety in these platforms and vehicles can improve SMEs' awareness and capacity on nutrition, thus helping to make their products more nutritious.

Low consumer awareness of healthy diets and nutrition

In economies that are in an advanced stage of digital transformation, the agrifood sector, local farmers and SMEs have already been tapping into this opportunity. Digital marketing and social-media apps encourage virtual meetings between local SMEs and consumers. The key value of social-media communication lies in peer-to-peer networking, enabling farmer-to-processing industry-to-consumer engagement in the agrifood industry (Stanley, 2013).

In LMICs, modern lifestyles are increasing preferences for and consumer awareness of healthy food, generating demand for more information on the origin of and production methods used in food. This has spurred the proliferation of food e-commerce platforms catering to various sources of demand, from fresh produce to ready-to-eat meals. Numerous e-commerce platforms have emerged to connect farmers with households or restaurants (Joiner and Okeleke, 2019). Twiga Foods,[5] for example, is a Kenyan mobile-based supply platform for fruit and vegetable SMEs. Chinese e-commerce platform Pinduoduo[6] helps farmers to deliver fresh produce to consumers, with over 586 000 merchants supporting more than 12 million farmers across the country.

2 https://www.gastrograph.com/

3 https://eit.europa.eu/our-communities/eit-food

4 https://smartagrihubs.eu/

5 https://twiga.ke/

6 https://en.pinduoduo.com/stories#agriculture

With consumers ever more interested in where their food comes from and how it is produced, SMEs could promote this information and the nutritional value of their foods through social media. In addition to encouraging the awareness of healthy food, this could demonstrate SMEs' ties to local communities and cultures, influencing consumer food preferences.

CONCLUSIONS AND RECOMMENDATIONS

This paper outlines some of the challenges SMEs are facing in transforming the nutrition sensitivity of their operations and presents some of the digital technologies that could help them to overcome these difficulties.

While the benefits of digital transformation are persuasive, it has come up against significant hurdles. Admittedly, some fundamental issues, such as infrastructure, regulatory frameworks and education, require considerable commitment and investment and may take some time. Other challenges include difficulty using software, data-usage concerns, disparate and propriety data formats and unclear returns on investment. There is also uncertainty about who will have access to farmers' data and how they will use it (Wiseman et al., 2019).

Still, some of the digital solutions suggested in this article could function well in LMICs, both specific technologies (such as smart supply chains based on blockchain, digital microfinance, eLearning and social-media marketing) and organizational solutions (such as digital incubators, accelerators and labs). Although many of these solutions do not apply specifically to nutritious foods, they could contribute to an enabling environment that favours nutrition-sensitive food systems or could be adapted to support the production and consumption of nutritious foods. For example, digital policies on agriculture and finance could be designed to specifically foster SMEs that produce nutritious foods. Technologies that analyse food quality and consumer preferences could be used to understand organoleptic demand for nutritious foods. Such information could guide activities along value chains.

Lastly, we offer the following considerations and suggestions for governments and policymakers.

1. Current digital solutions focus primarily on production and consumption. It would be beneficial to make them nutrition-sensitive and to explore solutions for other parts of the food value chain.
2. The actual capacities of SMEs and the state of local infrastructure must be considered when developing digital solutions. For example, simple apps that can run on low-speed internet connections and do not need cutting-edge hardware could be more suitable than complex apps.
3. To ensure that chosen solutions work well, it may be good practice to pilot them in a small market first, then scale them up to the whole region or country.
4. Inclusiveness should be emphasized. Digital technologies can potentially help to decrease hunger and malnutrition rates. The issue lies in how they are used and to what purpose. The current use of digital technologies is being driven by vested interests, often large corporations with profit as their primary and sole objective. Meanwhile, those people whose human rights are most at risk have no say in or access to these technologies.
5. Introducing digital tools to educational systems and for rural employment can empower rural communities, especially youth and women entrepreneurs. This measure could help them to become more competitive in the food system and put more high-quality, nutrition-rich products on the market.

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Digital marketing of harmful foods to children: A global concern

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ABSTRACT

Many countries have prioritized good nutrition and the prevention of non-communicable diseases in their efforts to meet the Sustainable Development Goals. While significant progress has been made, challenges remain in areas where policy initiatives are lacking, such as the digital marketing of high fat, salt and sugar (HFSS) foods to children. Both direct marketing through paid advertisements and indirect marketing through social-media influencers expose children to the promotion of unhealthy food. A dearth of clear laws governing international media publishers, coupled with weaknesses in monitoring systems, have left policymakers hesitant to take tangible action. This paper outlines the current landscape of digital marketing and a number of international policy measures that should be discussed to enhance child protection. Understanding the digital marketing ecosystem is key to identifying which organizations are involved in supplying and distributing digital advertisements and the brands being marketed. Effective identification can be hampered by the lack of a consistent system to tag HFSS advertisements. Current discussions on data privacy and how to protect children's privacy, in particular, provide an opportunity to explore new technological solutions, such as age-verification tools, that could be used to restrict children's exposure to digital marketing. Creating a common platform for the United Nations and its Members to foster dialogue and develop a coordinated policy response would further increase protection for children.

SITUATIONAL OVERVIEW

Non-communicable diseases (NCDs) are responsible for 41 million deaths every year, equivalent to 71 percent of all deaths globally, according to estimates by the Global Panel on Agriculture and Food Systems for Nutrition (Global Panel, 2016). Each year, 15 million people between the ages of 30 and 69 die from an NCD, and 85 percent of those deaths occur in low- and middle-income countries. Cardiovascular diseases, cancers, respiratory diseases and diabetes account for more than 80 percent of all NCD-related premature deaths. The use of tobacco, physical inactivity, the harmful use of alcohol and unhealthy diets all increase the risk of dying from NCDs. Furthermore, the availability of unhealthy foods, such as sugar-sweetened beverages, processed and ultra-processed foods, has increased dramatically (Global Panel, 2016).

Drastic changes to our food systems, including greater access to and availability of unhealthy foods, significantly raise the risk of people around the world developing obesity- and diet-related NCDs. Importantly, there is a growing body of evidence demonstrating that childhood overweight and obesity often lead to adulthood obesity, making overweight and obese young people more prone to developing NCDs (Simmonds et al., 2016).

Many countries have taken steps to address the inappropriate marketing of unhealthy foods and beverages to children. However, many rely on the self-regulation of the advertising industry and food manufacturers (WHO NCD Office, 2019), although this has been shown to be ineffective (WHO Regional Office for Europe, 2018). Furthermore, evidence suggests that current policies to reduce children's exposure to marketing of energy-dense, highly processed foods and beverages

that are high in saturated fats, trans fats, free sugars and/or salt (HFSS) have failed to have a significant impact (WHO Regional Office for Europe, 2016). While the World Health Assembly unanimously adopted a set of recommendations on marketing food and non-alcoholic beverages to children in May 2010, implementation has been lacklustre even though countries have repeatedly committed to halting the rise of childhood obesity by 2025 amid undeniable evidence that HFSS food marketing has a harmful impact on children's health and well-being (WHO, 2010).

The failure to regulate digital marketing of HFSS foods to children comes at a time when children's exposure to digital screens (computers, tablets and smart phones) has been increasing (Twenge, Martin and Spitzberg, 2019). Here, two troubling factors collide. Digital media have been shown to affect children's food preferences, as well as their purchase and consumption patterns. Consequently, the World Health Organization (WHO) has called for limitations on the digital marketing of unhealthy foods to children (WHO Regional Office for Europe, 2016).

Policymakers have found it difficult to take effective measures to tackle the inappropriate digital marketing of unhealthy foods and beverages to youths, however. One of the main obstacles is the lack of a comprehensive strategy to monitor and enforce their compliance, as most current policies struggle to keep pace with the food and advertising industries' varied and numerous approaches to marketing their products to children. Indeed, most countries do not have adequate restrictions to tackle the issue. Even the few countries that have introduced restrictions, such as Portugal (on HFSS foods) and Finland (on alcohol), lack a comprehensive strategy to monitor them. In some countries, the lack of monitoring systems has been a major reason to not introduce or to delay the introduction of new legislation.

To this end, the new WHO-UNICEF-Lancet Commission has proposed adding an Optional Protocol on commercial marketing and the targeting of children to the United Nations Convention on the Rights of the Child (United Nations, 1989), to better protect children against harmful marketing by legal means (Clark et al., 2020). Furthermore, user-generated content, such as that produced by social-media influencers and peer-to-peer sharing, has blurred the boundaries of what constitutes advertising, making it difficult to track and its impact hard to assess (Buchanan et al., 2018).

In response to these increasingly sophisticated digital marketing tactics, the WHO Regional Office for Europe has published a monitoring framework, known as CLICK, to help assess the extent of children's actual exposure to digital marketing on a regular basis (WHO NCD Office, 2019). This framework is flexible and can be adapted to national contexts to gather information on a broad range of products. Key steps in the framework include: (1) comprehension of the digital ecosystem, (2) the landscape of campaigns, (3) investigating exposure, (4) capture on screen and (5) knowledge sharing. As the technology and concepts in this area continue to grow, the monitoring tool is a crucial first step in tackling digital marketing to children and adolescents. CLICK clearly plots the digital marketing ecosystem to enable the identification of the stages involved in delivering a digital advertisement. It also enables the identification of the stakeholders and organizations involved in the advertising process, not just at the global level, but at national and local level (WHO NCD Office, 2019). For more details on CLICK, please see the article by Bica et al. in this publication.

NEXT STEPS

In addition to ensuring that effective monitoring systems exist, United Nations organizations, such as WHO, the United Nations Children's Fund (UNICEF) and the Office of Information and Communications Technology, should facilitate dialogue and implement plans to address other crucial issues. For instance, a CLICK data-collection pilot programme has discovered zero consistency in the tagging of digital advertisements (WHO NCD Office, 2019). This makes it difficult to identify the brand or product just by looking at the label (the tag) of the digital advertisement. Therefore, even when data are collected using the latest technology or by asking advertising agencies to provide data on advertisements in a particular country, it is not always possible to identify the ones related to food or HFSS foods. There is also insufficient transparency on so-called "walled-garden" advertising platforms, where companies such as Google and Facebook own and manage a huge database of users, but data and advertising explanations on how users are targeted are incomplete, vague and sometimes misleading (Andreou et al., 2018).

Marketing experts may see the absence of labelling criteria for digital advertisements as a creative opportunity to achieve maximum reach. However, if it hinders identification of the product or the brand for legal purposes, it cannot be deemed an acceptable practice. We believe all products on the market must be labelled appropriately, with the

brand clearly visible, so that the computers or individuals who monitor them are not intentionally or unintentionally misinformed or misled.

It would be a significant help if international organizations could facilitate a process to develop common criteria on how to label digital advertisements. This would allow the identification of digital advertisements to be conducted in a systematic and synchronized way globally and allow for comparison and categorization.

Even if advertisements for HFSS foods can be correctly identified and categorized, however, it is also important to identify children under the age of 18 when online, to protect them from harmful or misleading advertisements. Furthermore, many brands use social-media influencers to promote their products, complicating the challenges of categorizing and tagging advertisements. Such advertising does not necessarily reach a target audience by the traditional, monitored routes, but through channels such as Instagram stories, YouTube endorsements, TikTok videos or other sponsored posts.

Often, brands use child influencers to sway children's brand preferences through subconscious persuasion (De Vierman, Hudders and Nelson, 2019). This underscores the pressing need for national laws to cover digital marketing and social-media influencers, to protect children and adolescents from exposure to the marketing of unhealthy products.

Such laws do exist in a handful of countries, for example, in Portugal, where Law No. 30/2019 (Assembly of the Republic of Portugal, 2019) recently established restrictions on the marketing and advertising of HFSS foods. Marketing and advertising such foods is prohibited in educational institutions, on television and radio at times when a significant proportion of audience is under the age of 16 and on internet sites and in apps with content intended for people under the age of 16. In the past few years, Finland (Republic of Finland, 2014) and Lithuania (Republic of Lithuania, 2017) have also put in place strict marketing restrictions, albeit on alcohol, to protect young people. It is imperative that the global community convene legal experts to develop a model law that can be adapted and applied to national contexts.

A map of the digital marketing ecosystem has also revealed the automatic buying and selling of targeted advertising impressions, known as programmatic advertising. This means that when a child is online, two or more computer servers bid to get their attention or to distract them from what they were originally doing. It is unacceptable to commercialize children or, indeed, their time by bidding for their attention, especially from the perspective of protecting their rights and health, as guaranteed by Article 24 of the Convention of the Rights of the Child (United Nations, 1989).

There also ought to be a broader discussion on how to fund positive free online content for children, rather than allowing companies and advertising agencies to continuously exploit them through HFSS food advertisements online. One solution could be to set up a programmatic advertising system that is specifically tailored to the needs of children. This requires wider consultation with all relevant stakeholders. Naturally, if industry stakeholders are consulted, then safeguards must be implemented to ensure that no conflicts of interest arise; they should not be able to determine the rules or the monitoring methods for this new programmatic advertising system.

The European Union's General Data Protection Regulation has forged a new landscape for processing individual data (especially for minors) and targeted advertisements, including new constraints on what constitutes consent to the use of individual data and how users are targeted with advertisements based on such data. As the collection, holding and sharing of individuals' data cannot be processed without consent, there is an even more urgent need to identify children under the age of 18, as the conditions for giving consent vary depending on the cognitive capabilities of the person in question (Tatlow-Golden et al., 2017). When children's data are used, for example, parents need to give their consent.

There are currently many initiatives to develop technological applications for age verification, but we would recommend that international organizations facilitate the development of criteria for such age-verification tools, so that national governments can choose to endorse a common, internationally certified technology. We envision this process as being similar to how the WHO Regional Office for Europe developed its Nutrient Profile Model: member states were consulted and a common model was developed based on best-practice examples (WHO Regional Office for Europe, 2015).

CONCLUSION

For countries around the world to be more successful in curtailing the harmful digital marketing of HFSS foods to children and to encourage more countries to develop restrictions on such marketing, international monitoring capabilities and strategies must be improved in an informed and coordinated way. There are several essential steps we must take. First, we need to comprehensively map the digital marketing ecosystem to identify all relevant stakeholders. Second, we need to create common criteria for tagging advertisements. Third, we must develop a common tool for age verification. Rather than endorsing and using multiple initiatives, the United Nations and other international organizations should facilitate a process to find effective solutions to this global problem using a set of common and harmonized tools, so that we can respond to these new risks with appropriate standards and methods and ensure the well-being of all.

New model laws, based on consultations with legal experts, should be developed to cover indirect advertising by social-media influencers. Comprehensive monitoring systems, such as CLICK, developed by the WHO Regional Office for Europe, should be used by United Nations organizations to assess the situation regularly. Governments can also establish actions and mechanisms to collect regular data on national marketing campaigns and their reach. A range of such strategies facilitated by the United Nations, international organizations and countries will strengthen the national and global response to this growing threat to the well-being of our children and adolescents.

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WHO/EUROPE IMAGE LIBRARY

Innovation

CLICK: The WHO Europe framework to monitor the digital marketing of unhealthy foods to children and adolescents

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OVERVIEW

This paper presents CLICK, a monitoring framework developed by the World Health Organization European Office for the Prevention and Control of Noncommunicable Diseases (WHO NCD Office), to support countries in monitoring the digital marketing of unhealthy products to children (WHO NCD Office, 2019). We summarize its comprehensive and innovative approach, identifying the progress achieved and further measures required to strengthen the monitoring of digital marketing to children.

There is a "substantial, unequivocal" body of evidence that exposure to marketing of unhealthy food and beverages has a harmful impact on children's eating behaviour and body weight (WHO, 2018: 4; see also Boyland et al., 2016; Norman et al., 2016; UNICEF, 2019a; WHO, 2016). In 2010, based on the strength of this evidence, the World Health Assembly unanimously adopted the WHO Set of Recommendations on the Marketing of Foods and Non-alcoholic Beverages to Children (WHO, 2010). A central recommendation of the WHO Commission on Ending Childhood Obesity (WHO, 2016) was that children's exposure to such marketing be reduced. Unhealthy food marketing infringes multiple rights under the United Nations Convention on the Rights of the Child (United Nations, 1989), including the rights to health and to freedom from exploitation (WHO Regional Office for Europe, 2016; UNICEF, 2018).

Yet, despite repeated calls to action and political commitments, policy development is patchy (WHO, 2018), and children and adolescents are frequently exposed to marketing of numerous unhealthy products, specifically, alcoholic

drinks, foods and drinks high in saturated fat, salt and free sugars (HFSS) and tobacco, including new products such as electronic cigarettes (e-cigarettes) and other types of electronic nicotine-delivery systems. A particular challenge is digital or online marketing, which complements and amplifies the effects of other forms of marketing, enabling immersive, interactive and integrated marketing strategies (Kelly et al., 2015).

THE CLICK FRAMEWORK

Rapid digital marketing developments driving complexity in the number of technologies and companies involved in digital advertising, along with inaccessible 'black box' digital media platforms and systems, present substantial challenges to assessing children's actual exposure to digital marketing (Tatlow-Golden et al., 2017). Indeed, so complex is the digital ecosystem that it is often not immediately evident how to begin to gather relevant, representative data. Tools and protocols are urgently needed to facilitate the monitoring and implementation of the WHO Set of Recommendations in online settings. In response, the WHO Regional Office for Europe has developed the CLICK monitoring framework to support countries in monitoring the digital marketing of unhealthy products to children (WHO NCD Office, 2019).

Advertising has changed considerably in recent years, with a substantial increase in digital ad spending worldwide and a shift to mobile devices (eMarketer, 2020). Children and young people are among the most active users of mobile phones, social media and the internet (UNICEF, 2019b). Although, in principle, most social-media platforms require users to be aged 13 years or over, many younger children also actively engage in social media by accessing parents' accounts, creating their own accounts using false dates of birth, or by not signing in (for example, on YouTube) (WHO Regional Office for Europe, 2016; Potvin Kent et al., 2019).

All children under the age of 18 are vulnerable to the effects of digital marketing, as it operates through emotional and unconscious routes (Buchanan et al., 2018; Folkvord, 2020; Norman et al., 2018; Boyland and Tatlow-Golden, 2017). Younger children may be particularly susceptible, as their cognitive abilities are still developing. Older children and teenagers are especially susceptible to emotional, social and identity-based advertising (WHO Regional Office for Europe, 2016), responding more positively to social-media advertising posts for unhealthy foods than non-food or healthy food posts (Murphy et al., 2020).

Digital and mobile advertising has grown rapidly in the last decade, fuelled by the use of data for personalized and targeted advertising. This has been supported by global and regional technology platforms and algorithms that automate the buying and selling of targeted advertising impressions (known as programmatic advertising) rather than the traditional method of buying ad placements in specific publications (eMarketer, 2020).

There are two features of digital marketing that render it particularly opaque to external researchers. First, the evolution of digital programmatic advertising has resulted in a highly fragmented, complex, open advertising technology (adtech) ecosystem involving multiple players: publishers, intermediary agencies and advertising technology and data platforms. Its complexity and the fragmentation of consumer-content consumption mean it is currently impossible for any party involved in this multi-step process (publisher, media agency or brand) to specify all of the ads an individual user actually sees on their device.

The technology currently enables the targeting of advertising to specific people, but without accurate and open data on people's age, it is not possible to detect which viewers are children, or what the aggregate exposure to certain classes of advertising is. Even when companies make voluntary agreements to restrict marketing to children, in the current ecosystem, no brand (or other agent) has the power to fully control the process or verify its impact. The industry lacks a means to classify specific ads as restricted and there is no universal age verification system to accurately identify children. Consequently, programmatic marketing is particularly problematic, as it continues to deliver marketing of unhealthy products to children by default and by design.

Second, the global adtech ecosystem is dominated by 'walled-garden' advertising platforms, such as Google/YouTube, Facebook/Instagram, Amazon and emerging scale platforms like Snapchat and TikTok, which operate their own full-stack technology systems. These platforms do have the data and power to identify advertising consumption at the individual user level within their publisher universe, yet they are typically unwilling to share all of this information. For example, Facebook's Ad Library contains advertising

examples, yet there are questions about its comprehensiveness and representativeness (Rosenberg, 2019). Taken together, these two factors present major challenges to those who seek to understand the digital marketing exposure of children to unhealthy products that affect their preferences and behaviours.

The CLICK framework sets out five steps to provide a deeper insight and richer explanation of children's exposure to digital marketing:

- Comprehend the digital ecosystem, to understand the marketing ecosystem and identify children's online behaviours
- Landscape of campaigns, to evaluate major brands' leading media campaigns
- Investigate exposure, to assess paid-for digital marketing
- Capture on-screen, using screen-capture software to directly assess exposure to all forms of marketing, including paid-for and 'earned' media
- Knowledge sharing, to advance public education and policy advocacy.

Manual analysis methods show that children are exposed to digital marketing for unhealthy foods (Tan et al., 2018; Coates et al., 2019a; Potvin Kent et al., 2019; Qutteina et al., 2019). For smaller-scale, manual methods that fulfil several of CLICK's goals, a set of WHO Protocols has been developed, with step-by-step coding guidance and support (WHO NCD Office, 2020).

Many governments wishing to implement policies to restrict the digital marketing of unhealthy products require much more evidence and a comprehensive monitoring approach to support such action, but may not have the researcher resources or capacity to scale up manual methods. Technological innovation can play a crucial role in the development of tools to monitor exposure accurately and efficiently, meeting the goals of the CLICK framework, adapting to different national contexts and coping with multiple languages and forms of social media most commonly used by children. Invasive methodologies cannot be recommended to governments, as ethical considerations are crucial to the capture of young people's digital experience. Thus, striking the right balance between gathering accurate data and ethical privacy in assessing children's online behaviour is a considerable challenge that CLICK's technical innovations also aim to tackle.

Comprehend the digital ecosystem

To comprehend each country's digital marketing ecosystem, it is essential to identify which organizations supply and distribute digital advertisements locally and to understand the national ecosystem, which will include a mix of global, regional and local participants. Publicly available global data are insufficient to properly map national digital marketing ecosystems. Although global and regional tech platforms can be identified from desk research, further research and analysis are needed to map local agencies, demand-side platforms, data management platforms, supply-side platforms and publishers. Tools are required that evaluate and validate any publicly available data and identify the data available and required for different stakeholders, so that governments can compile a national picture. Building methods and national capacity perform this mapping are essential for countries to identify and address digital marketing.

Landscape of campaigns

To establish what type of advertisements young people are exposed to, assessing the leading ad campaigns can be valuable. Data mining is an innovative approach that can scan social-media content and routinely identify the leading campaigns. However, most countries do not have access to metadata from social media or from ad agencies, hindering their understanding. Once the ads are available, these can be analysed manually through content analysis. Further innovation would involve developing artificial intelligence (AI) tools that could automatically evaluate manually gathered advertising content. Such tools are discussed in more detail below in relation to the analysis of large volumes of data.

Investigate exposure

Due to the individualized nature of digital marketing, collecting data from children's own devices as they use them is the only means of better understanding their actual exposure to unhealthy products. Self-reported exposure to advertisements is likely to result in under-reporting, so applications that capture advertisements delivered in real time are preferable, should they prove valid. Such technology is used by marketing organizations to monitor the marketing of competitive brands and can be used to assess paid-for advertisements (marketing content paid by brands to appear on publishers' websites, a user's social-media channels or channels with which children interact, for example, by clicking on an ad on YouTube). At present, these applications claim to collect time spent on each platform, every event and ad clicked, the brand advertised and the likely content of any banner advertisement. However, validation data for such approaches are required.

Capture on-screen

In addition to direct paid advertising, children and adolescents are exposed to indirect unhealthy product marketing on social media from multiple sources, including social-media influencers, celebrity-generated content and product placement (WHO, 2016; Potvin Kent et al., 2019; Coates et al., 2019a; De Veirman, Hudder and Nelson, 2019). Indeed, the 'brand activation' market is now estimated to be three times the size of the entire advertising market (Precourt, 2018). Content produced by influencers and shared by peers plays a significant role in children's online experience and young people are more likely to trust this kind of content than other types of media (WHO, 2016; Coates et al., 2020). There is increasing evidence of the impact of this form of marketing on children's eating behaviour (Coates et al., 2019b; Coates et al., 2019c; Smits et al., 2019), yet obtaining reliable metrics on exposure remains difficult.

Eye-tracking methods with manual analysis have been used effectively to provide strong research evidence of high levels of food marketing exposure (Potvin Kent et al., 2019). However, the cost, logistics and time involved limit its expansion. Furthermore, these data cannot be collected over extended periods of time and children may change their conduct if they know they are being observed. These factors point to the benefits of developing and validating new technology.

In addition to eye-tracking, CLICK specifies applications that would address this challenge, such as software that automatically takes screenshots of what children are exposed to on social media. The challenge is to capture relevant advertisements and marketing, rather than the whole screen experience and to minimize the capture of sensitive personal data, such as emails and text messages. Innovative screen-capture software has now been developed to use within the CLICK framework. This will only capture the screen when a user is on a specified application, such as a social-media platform, and is a significant innovation in this field.

When data are collected at scale like this, sophisticated and reliable AI tools, trained through the analysis of large volumes of images collected by screen-capture software, are required to recognize images for relevant products and brands (such as HFSS foods and alcohol) to facilitate the rapid, cost-effective analysis of children's exposure to advertising. This is a significant area for future investigation in which public health researchers and technology experts should work collaboratively to validate any tools built.

Lastly, monitoring children and young people's exposure to unhealthy marketing alone is insufficient. Mechanisms are required to restrict exposure to age-inappropriate marketing – namely, age verification tools – as users do not accurately report their age online and different companies use different tools. A consistent, interoperable system could then work as an ad block, preventing all inappropriate content, including HFSS advertising, from reaching the child.

The CLICK framework's contribution combines public health approaches, both researcher- and technology-led, to monitor unhealthy and inappropriate content reaching children, setting a global benchmark for data-collection and analysis goals. Its high-level nature, outlining overarching goals and potential methods, is its strength, in that it allows for country- and resource-specific solutions to be developed. This is evidenced by the ongoing development of innovative methods and protocols for both manual and automated solutions to the challenges presented by a complex digital ecosystem. Implementing this framework will allow governments, under the United Nations Convention on the Rights of the Child, to comply with duty bearers' responsibility to support and protect children's rights, including to the best possible standards of health.

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FAO/MOHAMMAD RAKIBUL HASAN

PLUS School Menus: The future of school menu design

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INTRODUCTION

School feeding programmes increase school attendance and provide children with healthy meals, generating benefits in terms of education, health, nutrition, local agriculture and social protection. When these programmes are linked to the produce of smallholder farmers (home-grown school feeding, or HGSF), they underpin local food systems and contribute even more to human capital and community development.

For decades, the World Food Programme (WFP) and its partners have been supporting national governments in designing, developing and strengthening school feeding programmes. In the spirit of continued improvement in programme delivery and the provision of technical assistance, in 2018, WFP, as the lead United Nations agency for school feeding, with the support of its partners, began to develop the PLUS School Menus tool. The project aims to optimize the planning of school meals for nutrition, local economic impact and cost efficiency.

In January 2020, WFP launched its new school feeding strategy for 2020–2030 (WFP, 2020). Within this framework, PLUS School Menus is a key initiative to strengthen programmatic approaches in key areas.

THE POTENTIAL OF SCHOOLS TO IMPROVE NUTRITION

Globally, the nutritional situation is plagued by persistently high stunting rates, widespread micronutrient deficiencies and a steady increase in overweight and obesity, with different forms of malnutrition coexisting within the same country, household and even the same individual. Almost no country is spared this multiple burden of malnutrition. The 2018 Global Nutrition Report indicated that 88 percent of countries were experiencing a high level of at least two of these types of malnutrition: childhood stunting, anaemia in women of reproductive age or overweight among women. Twenty-nine percent of countries were experiencing high levels of all three forms of malnutrition (Development Initiatives, 2018).

While the focus to improve nutrition has been and should remain on the first 1 000 days of a child's life, the critical window from conception to two years of age, recent evidence calls for a move to a new 8 000-day paradigm (Bundy et al., 2018). Investing in a child's health, nutrition and learning throughout childhood and adolescence is critical to boost human capital – the sum of a population's health, skills, knowledge and experience. Human capital matters for people, economies, societies and for global stability down through the generations (Gatti et al., 2018).

Diets and nutrition of school-aged children

While data on the nutritional status of school-aged children are often limited or unavailable at the sub-national level, global and regional trends show that children's diets (and,

therefore, their nutrient intakes) increasingly reflect the global "nutrition transition" – a shift from largely plant-based, minimally processed diets to the consumption of highly refined carbohydrates, packaged foods, large amounts of animal-source foods and high intakes of sodium, refined fats and sugar. School-aged children have low dietary diversity, eat few nutrient-rich foods and consume too many unhealthy snacks (Development Initiatives, 2018). Children commonly miss breakfast, depriving them of essential energy for concentration in class. Nearly half the world's schoolchildren, some 310 million, in low- and middle-income countries (LMICs) eat a daily meal at school. For many, this is the only meal they can depend on. Fifty percent of adolescent girls in LMICs do not eat three meals per day and most do not eat breakfast (Keats et al., 2018).

As a result of changing diets and food environments, overweight and obesity have now become major health concerns for school-aged children worldwide. Of the 638 million school-aged children globally, 131 million, or around 20 percent, are overweight (UNICEF, 2019). It is predicted that the number of obese children aged 5 to 19 years will almost double by 2030, with LMICs seeing rapid rises (World Obesity, 2019). Iron, vitamin A, zinc, folate, calcium and iodine are among the common micronutrient deficiencies.

Tackling the causes of malnutrition through school-based programmes

There is global recognition that schools are an effective platform for addressing the underlying drivers of malnutrition, as exemplified by the United Nations System Standing Committee on Nutrition's 2017 statement (UNSCN, 2017). Global food and nutrition policy frameworks and action plans call for making safe, nutritious and adequate food available in schools (FAO and WHO, 2014; WHO, 2013; Global Panel, 2015). Amid an obesity epidemic and the coexistence of different forms of malnutrition, recent publications have further stressed the important role of schools, school feeding programmes and school environments as a double-duty action to combat all forms of malnutrition (UNICEF, 2019; Hawkes et al., 2019).

Indeed, schools offer the opportunity to trigger important shifts among school-aged children and often the families and communities that nurture them.

- Healthy and safe school meals help meet daily nutrient needs, promote dietary diversity and fill important nutrient gaps at critical points in the lifecycle. Meals should be tailored to different age groups, be safe and culturally appropriate.
- Health and nutrition knowledge and behaviours can be influenced by meaningful school-based food and nutrition education strategies, behavioural change activities and the appropriate enabling environment (such as the provision of hand-washing stations and healthy food environments).
- Complementary health and wellness services provided at school allow children to benefit from a full package of interventions, such as deworming, micronutrient supplementation, health counselling and access to WASH-related services,[1] to address the multiple and complex causes of malnutrition.
- HGSF promotes linkages with local food producers to provide school-aged children with safe, diverse and nutritious food while leveraging institutional demand to promote livelihoods and incentivizing the availability and affordability of nutritious foods (FAO and WFP, 2018).

INNOVATIVE SOFTWARE TO OPTIMIZE SCHOOL FEEDING MENUS

The momentum surrounding the role of schools in nutrition and school feeding programmes has triggered an increase in country demand for support in designing more nutritious and diverse school menus, including the use of locally available foods, while balancing budgetary constraints. Food purchases constitute the most significant expenditure for school feeding programmes. Deciding what to buy, at what price and from whom are challenging decisions with implications for final menu composition, nutritional value and (local) food systems. Manual trial-and-error-based processes can be cumbersome and fail to generate maximum potential from the multi-million-dollar investments involved. The possibility of feeding more children with more nutritious and diverse meals is, thus, lost in arduous spreadsheet calculations.

Designing a menu is an extremely complex task. There are many parameters to consider, involving various risks and opportunity costs:

- A menu may include more vegetables and less rice to increase micronutrients, but this may result in the loss of kilocalories or an increase in meal cost, potentially limiting the number of children supported by the programme.

1 WASH = water, sanitation and hygiene.

- The menu design may not consider locally grown vegetables (often higher in price), though the nutritional value and the impact on farmers' livelihoods may be worth the extra cost.
- One can calculate menus with high nutritional values, but the cost may be unfeasibly high.
- Local food preferences should be factored in, adding an additional layer of complexity to designing an optimal school menu.
- Available food price data, especially for nutritious and fresh foods (for example, fruit and vegetables), are often limited and datasets are sometimes not interchangeable. Some initiatives are ongoing to address the issue, including the collection of regular data for additional foods and the homogenization of data collection and management.
- Diversifying school meals with local foods brings an extra set of challenges, such as seasonal availability, uneven or limited local production capacity to meet school needs, limited or lost knowledge about resilient and nutritious native crops, limited price information and food safety issues.

There are technological solutions for designing school meals, each with different advantages. Table 1 shows some of the tools that have been developed to calculate and optimize the nutrition content of food baskets. NutVal is commonly used, but does not allow the optimization of food baskets for content or cost. More advanced software tools include Cost of the Diet, which calculates the amount and combination of foods needed to provide individuals or households with average energy needs and recommended nutrient intakes (RNI) of protein, fat and micronutrients at the lowest cost. The Partnership for Child Development (PCD) School Meals Planner is a software tool specifically designed for school-meal programmes, which creates nutritionally balanced and market-costed school meals based on daily RNI. The tool has been piloted in several countries, including Botswana, Ghana and Nigeria. PLUS software, with its optimization function, also with regard to using locally sourced foods, complements existing meal-design tools.

Table 1. SOFTWARE TOOLS TO CALCULATE AND OPTIMIZE THE NUTRIENT CONTENT OF SCHOOL MEALS

Tools	Objective	More info
NutVal	• A spreadsheet application to calculate the nutritional content of a combination of food items; it shows the percentage of RNI met for energy, protein, fat, 12 vitamins and seven minerals. • Use for food-assistance programming (planning, monitoring), including general food distribution, cash-based transfers and school feeding.	Last updated version (v4.1) in 2015 Available at: http://www.nutval.net/
Cost of the Diet	• Software to optimize food composition to meet 100 percent of individual RNIs in the cheapest possible way. • Based on linear programming, which allows optimization. • Does not provide menus, but a theoretical combination of nutritious food locally available in markets that meet nutrient needs at the lowest cost. • Tool has been used in WFP Fill the Nutrient Gap assessments to examine the quality of school meals.	Available at: https://www.heacod.org/en-gb/Pages/SWCotD.aspx
PCD School Meals Planner	• A tool designed specifically for school-meal programmes. • Creates nutritionally balanced and market-costed school meals using daily RNI. • Piloted in Botswana, Ghana and Nigeria.	Available at: http://hgsf-global.org/en/bank/menu-planner
PLUS School Menus	• A tool designed specifically for school-meal programmes. • Based on mathematical optimization algorithms. • Calculates the most cost-effective menus (for up to four weeks), covering the nutritional needs of children from different age groups and optimizing the use of locally sourced foods. • Piloted in Bhutan, achieving a 20 percent cost reduction and 70 percent increase in food products from smallholder farmers. • Five new pilots planned for 2020; beginning of global scale-up for 2021.	Under development (Beta version available for testing; v1.0 release expected in July 2020)

WFP'S EXPERIENCE

WFP supports school-based programmes in 71 countries, providing direct implementation and lending technical assistance to governments. In recent years, the agency has renewed its commitment to supporting the health and nutrition of school-aged children, establishing a dedicated school-based programmes division and publishing a 10-year strategy (WFP, 2020).

In line with the lifecycle approach promoted by the WFP Nutrition Policy 2017–2021 (WFP, 2017a), the strategy calls for a new partnerships and advocates for meeting the health and nutrition needs of school-aged children and adolescents to break the cycle of malnutrition and contribute to human capital development (WFP, 2020). WFP also commits to nutrition-sensitive school feeding, including through the delivery of healthy school meals and snacks that meet established nutritional standards (WFP, 2017b). PLUS School Menus was created to facilitate progress in this regard.

In 2008, WFP began exploring how food purchases could help to develop staple crop markets and spur improvements in smallholder agriculture. It has since developed corporate agricultural market-support activities for smallholders, aimed at promoting farmer connections to formal markets to strengthen their income-generating opportunities and, ultimately, their livelihoods. Beyond WFP's own demand for large amounts of staple foods to supply its assistance operations, the organization promotes connections with private-sector buyers and government institutions and programmes, including school feeding.

In terms of food-basket composition, in addition to the conventional grains and pulses that have typically been part of WFP's pro-smallholder procurement over the past decade, WFP is increasingly promoting the purchase of local fresh products for HGSF programmes. In several countries, the purchase of maize, rice, sorghum and beans from local producers is accompanied by fruit, vegetables, eggs and dairy products, made possible by shorter supply chains and significantly increasing the nutritional value of school meals.

WFP's HGSF work contributes to improving both the health and nutrition of school-aged children and the livelihoods of smallholder farmers. WFP's Local and Regional Food Procurement Policy (WFP, 2019), which seeks to strengthen the efficiency and effectiveness of the organization's local and regional procurement, also promotes HGSF programmes. Ensuring reliable supplies of food for WFP operations, while supporting smallholder farmers and strengthening food systems, are key elements of this policy.

Over the past few years, WFP has made considerable efforts to prioritize innovation and digitalization initiatives. With the launch of the Innovation Accelerator in 2016,[2] it created a platform to identify, support and scale up innovative ideas within the organization and beyond. PLUS School Menus, with financial and technical support from the accelerator, became one of those innovation projects.

Strategic partners

In 2020, the Food and Agriculture Organization of the United Nations (FAO) joined the PLUS team, providing expertise on national nutritional guidelines and standards for school meals. There are wide disparities in the availability and scope of such guidelines for school meals, as well as in the process for their development in LMICs (Aliyar et al., 2015; FAO, 2019). FAO and WFP are working together to develop a global methodology for school-meal nutrition guidelines and standards. These are just some of the key areas in which FAO and WFP are joining forces.

The PLUS team is fostering technical collaborations with other key actors, such as PCD, which has vast experience in assisting countries in setting up effective and sustainable HGSF programmes, including menu design, and the International Food Policy Research Institute. The Sodexo Stop Hunger Foundation and the WFP Innovation Accelerator have been critical partners too, providing seed funding, technical inputs and mentorship.

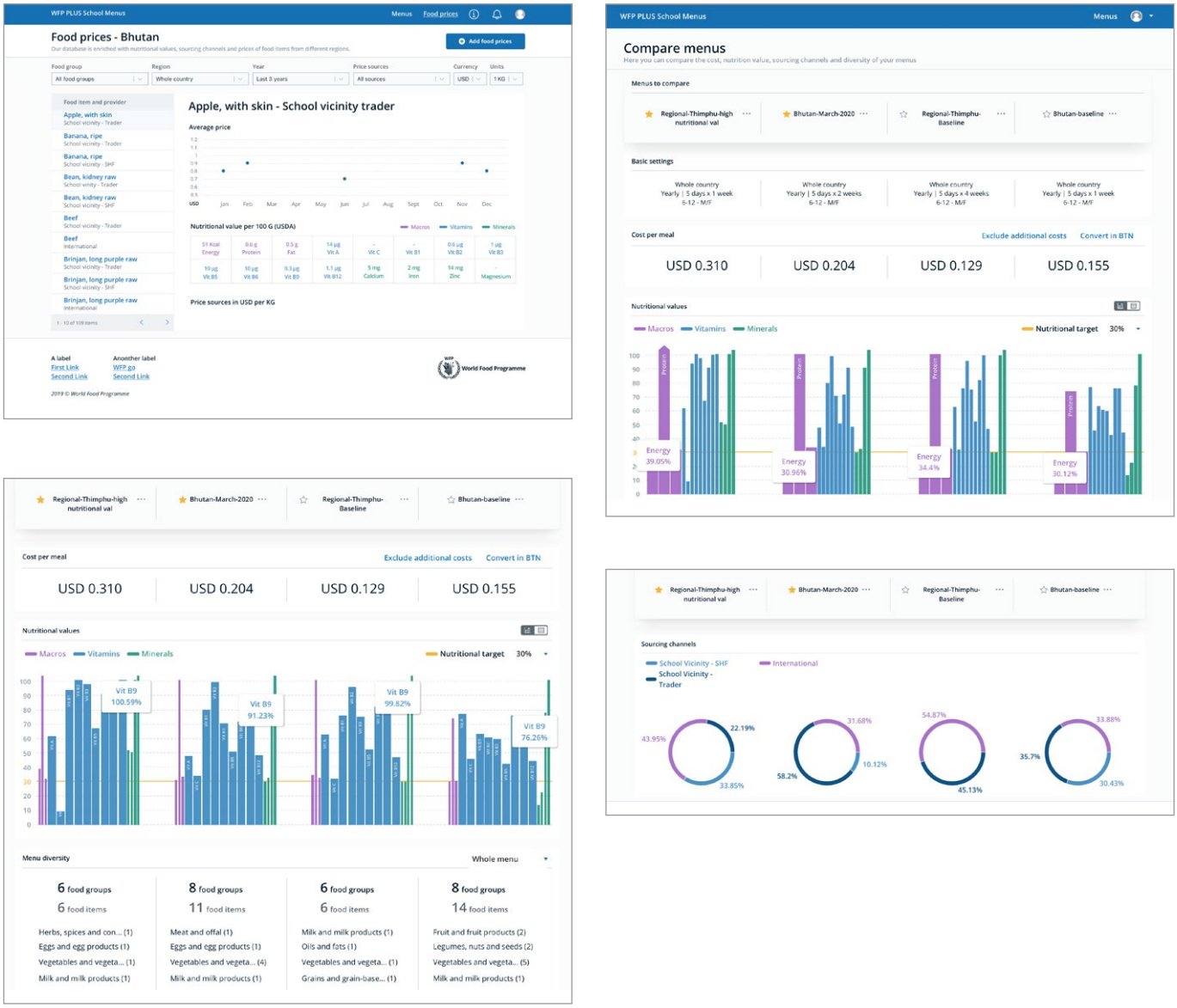
2 https://innovation.wfp.org/

The software

The PLUS School Menus software is the first digital solution that optimizes school menus by making them simultaneously more nutritious, cost-efficient and locally sourced. PLUS uses a set of databases (food prices and food composition tables) and an advanced mathematical algorithm to calculate a series of meals to ensure simultaneously cost-efficient, nutritious, locally sourced food. Food tables, prices and data can be customized to any country need, facilitating the usage of local commodities.

The tool is designed to offer flexibility and minimize the time required for menu creation. After defining the context (location, seasonality, food prices, target age group and number of meals), the user sets up requirements for nutrition (the percentage of daily macro- and micronutrients to be provided), food origin (a minimum percentage of food from smallholder farmers or limits on imports) and menu composition (for example, three fruits a week, rice on Mondays, a bean portion of 20–40 grams, etc.). The tool then calculates an optimal menu, at the cheapest price, for up to four weeks of meals (see Figure 1 for an example).

Figure 1. EXAMPLE OF THE PRELIMINARY BETA VERSION-GENERATED RESULTS PAGE



Source: *World Food Programme*

STEPS IN THE DEVELOPMENT OF THE PLUS SOFTWARE

From proof of concept to beta version

The initial proof of concept of the PLUS School Menus software was developed in 2018 and received the WFP Innovation Challenge Award for its approach to menu creation. The original version had no interface and its calculation capacity was very limited, yet it was clear that the tool could be a game-changer in school menu design thanks to its cost, nutrition, sourcing, diversity and local-preference dimensions.

To ensure usability, the project went through a human-centred design process, in which 14 potential users from around the world were interviewed and given a prototype of the interface. Twenty-five country offices and all six WFP regions volunteered to test it. Eventually, after 18 months of work by a team of experts from different fields, the PLUS School Menus software was launched as a beta version in July 2019.

The Bhutan case study

The Government of Bhutan was the first country to support the development and piloting of PLUS as an operational application. Bhutan has launched an ambitious, comprehensive national school feeding programme with a view to providing more nutritious and locally sourced meals. Most food consumed in Bhutan is imported and there is an ongoing national effort to step up local substitution. In this context, Bhutan's Ministry of Education sought WFP's assistance in designing improved school menus at sub-national level.

This initial pilot allowed WFP to validate two big benefits of the tool. First, the tool is able to largely improve and adapt food baskets for school feeding programmes. This includes substantial cost savings without reducing quality and the flexibility to adapt to local challenges and eating habits. According to the Country Director of WFP Bhutan PLUS has the ability to convert "nutrition deficiencies into agriculture demand".

Second, the task of creating menus becomes much easier with PLUS School Menus. One of the first field users of the tool said: "Now I can create more nutritious menus that are more local and less costly, in minutes instead of weeks".

PLUS software was able to calculate new food baskets, bringing large improvements in a very short period of time. The first ever PLUS-designed menu was implemented in the region of Punakha and underscored the huge potential of the software to improve school-feeding food baskets. The PLUS menu had the same nutrient content as the previous school menu, but was 20 percent cheaper and sourced 17 percent of food directly from local farmers – a 70 percent increase from before, all while respecting local eating habits. The only training the first two users required (a WFP programme officer and a government nutritionist) was a two-hour in-person session and a few remote follow-up calls.

The test also showed areas for development, including further parameters to create menus of high gastronomical complexity (such as those served in Bhutan) and enhancements to the user interface.

NEXT STEPS AND COUNTRY PILOTS

The tool is expected to be ready for global release in 2021. Priority areas for 2020 include technical improvements, the implementation of strategic partnerships and the completion of country pilots. A key 2020 objective is to enable the tool to develop even more complex school menus, including any type of traditional recipe.

FAO/MANAN VATSYAYANA

Figure 2. HOW CAN PLUS DEVELOP SCHOOL MENUS THAT ARE CLOSER TO LOCAL RECIPES?

PLUS to propose recipes

PLUS creates an optimal list of food items and proposes meal sizes per day, following a desired menu structure. Using the list created by the software, a cook can use "gastronomical sense" to create a recipe with those ingredients. This approach works optimally for most programmes in which menus follow a simple pattern (namely, grain + legume + vegetable relish + oil + salt).

PLUS to guide recipe creation

In a first iteration (which could well be the "PLUS to propose recipes" approach), PLUS creates an optimal menu, effectively identifying the most cost-effective ingredients based on the nutritional, sourcing, diversity and menu-structure conditions input into the tool. Based on these, PLUS allows users to indicate how to organize those ingredients (and additional ones) into a known recipe. The software will then provide the right measurements for the recipe, accomplishing nutritional, cost and sourcing optimization.

PLUS to choose from a list of recipes

Using the 'Choose from a list of recipes' option, a functionality currently under development, it will be possible to choose the most convenient recipe from a database or combine a given recipe with other elements (for example, a main dish with a fruit).

Source: *World Food Programme*

Another goal is for all governments, WFP and partners involved in school feeding programmes worldwide to have free online access to the tool, to deliver greater impact in terms of programme coverage, nutritious meals and local agriculture. Ensuring a user-friendly and intuitive tool to facilitate navigation and minimize training time are key to enabling the successful deployment of the tool.

In 2020, the PLUS School Meals tool will be piloted in up to five countries. This phase aims to identify the good practices and challenges of using the tool in different contexts and to measure the amount of training required to master it. Discussions with several donors and governments are underway in a bid to gain support for piloting and implementing the software.

In Bhutan, the tool will be scaled up across the Trongsa district and expanded to other areas under the government's local-farmer initiatives. It is expected to scale up to inform school feeding food-basket decisions, impacting all 86 000 children benefiting from national school feeding and nutrition programmes.

RECOGNITION AND POTENTIAL

The potential of PLUS School Menus has been recognized in the humanitarian and development community. In October 2019, the PLUS team was invited by the Innovation Accelerator office to participate in the first ever WFP Scale-up Bootcamp in Silicon Valley, CA, where it received technical advice on improved infrastructure, interface and design from world-class information technology experts from Airbnb, Salesforce, Orange and others. Furthermore, the project was selected for the Global Best Practices Award at the World Expo Dubai 2020 in the "Water, Food and Energy Security" category.

The impacts of the PLUS tool can go beyond school-aged children, however. Understanding the exact amount of food a child should eat, while considering limitations such as budget, local food availability and taste/cultural preferences, can inform local food production and improve population health, nutrition and livelihoods.

The expansion of PLUS School Menus will require the development of a strong network of partnerships, including governments and non-government organizations. WFP's ongoing technical collaboration with FAO and PCD will progressively strengthen the evidence base underpinning the tool and ensure technical consistency as it evolves. The overall objective of these joint efforts remains to support governments in providing more nutritious, more local and more cost-effective school meals to the world's most vulnerable children.

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Food salvaging to alleviate hunger and food insecurity: The role of mobile technology

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INTRODUCTION

Food security and hunger is a major public health issue, with 820 million hungry people globally (WFP, 2020a). Countries are having to face the triple burden of malnutrition: the coexistence of undernutrition, overnutrition and micronutrient deficiencies (Development Initiatives, 2018). The COVID-19 crisis has exacerbated the problem and levels of hunger and food insecurity are expected to double if urgent action is not taken (WFP, 2020a).

In the United States of America, alone, over 11 percent of households (14.3 million) are food insecure (USDA, 2019) and that rate is rising sharply due to COVID-19 (Fitzpatrick, Harris and Drawve, 2020). Among Americans, the "meal gap", or shortfall in meals to adequately feed the population, is estimated at 7 billion a year (Feeding America, 2019). The United States has been extensively affected by COVID-19 (Johns Hopkins University, 2020) and new groups are now vulnerable to hunger, including older people, those who have lost jobs and children who depend on meals at schools that are closed.

Even prior to the pandemic, it was well documented that the world was set to produce insufficient food to meet the needs of its population by 2050, in part due to the challenges of climate extremes, conflict and economic downturn (FAO et al., 2019; Willett et al., 2019). In contrast, evidence suggests that around one-third of all food produced globally is wasted (FAO, 2019), in particular, nutrient-dense foods such as fruits, vegetables and dairy. Therefore, a key strategy to tackle malnutrition in all its forms is to divert food, particularly perishables, from being wasted and redirect it to those who are food insecure.

In this article, we discuss the role of a novel app, called Food2Share, developed at New York University (NYU). We describe the potential of the app to alleviate hunger and food insecurity and simultaneously reduce food waste. The app is an example of a digital marketplace, designed to connect stakeholders and local communities, to help vulnerable New York City populations to obtain food. The app will be instrumental in scaling up efforts to combat food insecurity and to provide safe and nutritious foods through widespread local community outreach. Lastly, we discuss how the Food2Share app may be adapted for global settings – particularly relevant during the COVID-19 pandemic.

UNDERSTANDING FOOD WASTE: A SNAPSHOT

Food waste occurs at the food production, procurement, retail and consumption stages. The world's industrialized countries produce more than USD 680 billion worth of food waste every year, while developing countries produce less than half that amount (ReFED, 2016). More than 40 percent of waste occurs at the retail and consumer levels (FAO, 2019). The United States, alone, wastes more than 200 million tons of food annually, equivalent to the net food production of sub-Saharan Africa. It costs the country over USD 220 billion annually to produce, transport and discard the food that is wasted (ReFED, 2016).

Both developed and emerging economies have witnessed an industrial food revolution over the past few decades (Parekh, Juul and Kirchner, 2019). The food environment has been transformed from traditional wet markets and small speciality retailers into extensive organized networks of retail stores and supermarkets that carry a large variety of foods, in particular, industrially processed and imported foods (Parekh, Juul and Kirchner, 2019). In these new retail settings, the use of strict quality standards, expiration dates and an over-emphasis on the appearance of the food has contributed to significant amounts of food being discarded (FAO, 2019). Furthermore, supermarkets typically use attractive marketing strategies and steep discounts to increase consumer purchases, but unsold products and products past or close to their expiry dates are often discarded and excluded from such sales.

The proliferation of the food industry and its new retail formats in emerging economies and the omnipresence of highly processed foods will intensify retail and consumer-level food waste globally and developing-country waste may mimic that of high-income countries (ReFED, 2016).

Another major source of food waste is the restaurant industry. Presenting only "visually attractive" foods to customers in a bid to boost sales, discarding imperfect foods and serving large-sized portions has led to significant amounts of waste (ReFED, 2016). Supermarkets, restaurants and food establishments are obvious targets for channelling food waste to consumption.

A DIGITAL SOLUTION TO MITIGATE FOOD WASTE AND FOOD INSECURITY: THE FOOD2SHARE APP

Several technology-focused initiatives around the world are successfully offering solutions to food waste (WFP, 2018). Hungry Harvest (Hungry Harvest, 2018) and Imperfect Foods (Imperfect Foods, n.d.), for example, deliver "imperfect" food produce to individuals. A Romanian start-up, Neurolabs (Neurolabs, n.d.), makes digital food-purchase forecasts for restaurants and supermarkets, making planning more efficient and reducing their food waste by up to 40 percent. These examples provide the impetus for wider use of technology to step up such efforts.

In an era in which 83–94 percent of people own mobile phones (73 percent of people in developed economies and 45 percent in emerging economies own smartphones), mobile-phone technology can undoubtedly revolutionize and scale up efforts to reduce food insecurity and food waste (Taylor and Silver, 2019). Such efforts are particularly relevant against the backdrop of the COVID-19 pandemic, which has exacerbated acute hunger and widened the "meal gap".

Given the importance and success of mobile health (mHealth) interventions in public health (Marcolino et al., 2018; Bendtsen et al., 2020), combined with the growing use of mobile-phone technology, we present an example of how mobile apps can be used not only to reduce food insecurity and hunger, but also to mitigate food waste and regain the otherwise lost nutritional potential of the food in question (Global Panel, 2018).

Using the Food2share app to salvage food

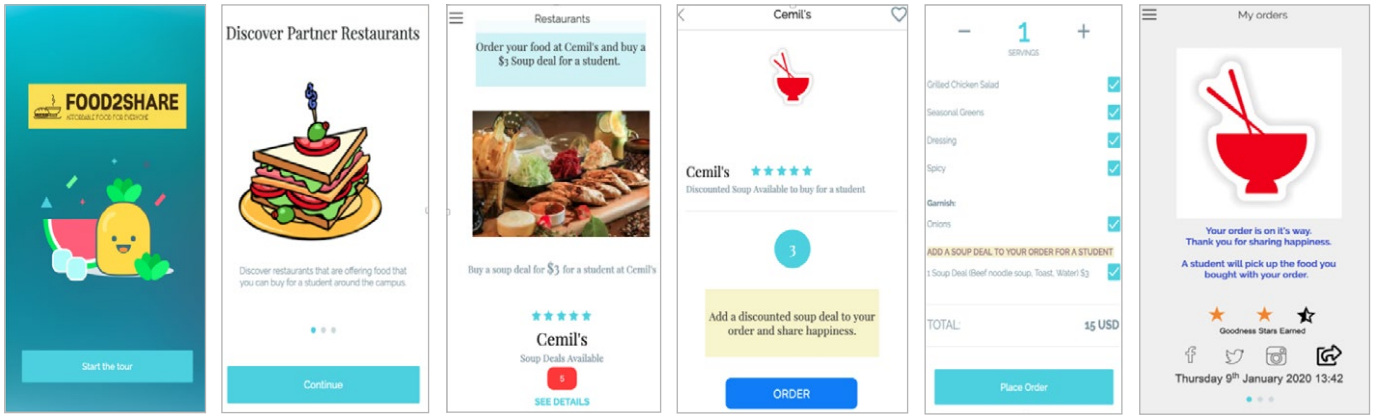
The Public Health Nutrition research group and technology experts at New York University have partnered to develop a prototype app, Food2Share, which connects food-insecure individuals with food establishments. Food salvaging is a strategy to recover food that would otherwise go to waste from restaurants, supermarkets and other food establishments and redistribute it to local food programmes and communities (ReFED, 2016). The aim of the app is to improve and scale up food salvaging and redistribution efforts.

This app is currently in final developmental at NYU and designed initially for use in New York City communities. Through the app, individuals can claim food from local restaurants willing to provide free or highly discounted food, donated by customers through a "Buy Food to Share" feature. Customers can choose to add a meal, discounted by the food establishment, when purchasing their own food items through the app. The donated meal then becomes available to a person in need and the donor receives a receipt for tax-deduction purposes. The app continuously collects purchase data and computes the associated tax benefits, keeping a record of charitable contributions by logging the dollar equivalent of the food donated.

The app monitors data on meals distributed and meals wasted to guide further interventions. In the next phase, it will be expanded to provide country- and context-specific nutrition- and food-related media-literacy programmes to users, with a view to influencing consumer behaviour and attitudes to waste. It will educate and guide food establishments, equipping them with skills to increase efficiency in food procurement, menu planning and food preparation, all aimed at reducing waste. The nutrition-literacy component will educate users on the negative aspects of consuming heavily marketed, highly processed foods. When an individual uses the app to choose their meal, a nutrient-dense, healthy option will be suggested. There will be a short video and step-by-step guidance at every stage (Figure 1) to help individuals navigate the process, to cater for individuals with low digital literacy.

The fully designed Food2Share app will be adaptable to numerous countries and regions and offer language options and culturally appropriate food choices. NYU will provide technological instructions and training for institutions and countries, so that it can be used on a large scale.

Figure 1. STEP-BY-STEP FUNCTIONALITY OF THE FOOD2SHARE APP



Source: *NYU*

CONCLUSION

To ensure that everyone has access to sufficient food, we must innovate by developing technology-enabled initiatives to increase food security and reduce food waste. Public-private partnerships can yield initiatives that can be replicated globally. Digital platforms need to be piloted to ensure that they are scalable and sustainable. Evaluation must ensure access to vulnerable, food-insecure populations. During the COVID-19 pandemic, with food establishments forced to close, many owners have risen to the challenge of providing food to those in need and to front-line responders through grassroots food-distribution initiatives. Scaling up these initiatives using technology and applying them to the global context could expand the efforts we have witnessed during the crisis.

The Food2Share app is one illustration of a community initiative that connects food-insecure individuals with food establishments with excess prepared food and individuals willing to engage in helping those in need. Benefits include less food waste, access to healthy food and enhanced nutritional potential, tax incentives for food providers and donors. In closing, such technology-enabled initiatives will contribute to the achievement of multiple Sustainable Development Goals (SDGs), such as reducing poverty (SDG 1), achieving zero hunger (SDG 2) and improving sustainability (SDG 15)(FAO, 2019; WFP, 2020b).

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Digital technology to promote inclusion and quality nutrition care for children with disabilities

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INTRODUCTION

Adoption of the 2030 Agenda (United Nations, 2015a) and the Sustainable Development Goals (SDGs) (United Nations, 2015b) has put the spotlight on global commitments and efforts to end hunger and all forms of malnutrition for children under the age of 5 years, with increased attention on reaching the most marginalized and "leaving no one behind". Despite global efforts, inequities persist across nutrition outcomes (FAO et al., 2019). Progress to reduce malnutrition has been too slow to meet the 2030 goals and is now being threatened by the COVID-19 pandemic. This lag in progress is particularly true for the estimated 93 million children worldwide who are living with disabilities (UNICEF, 2013).

Overall, children with disabilities are three times more likely to be malnourished and twice as likely to die from malnutrition than children without disabilities (Kuper and Heydt, 2019). Those with feeding difficulties are particularly vulnerable to malnutrition. Up to 85 percent of children with developmental disabilities experience feeding difficulties, such as difficulty swallowing, coughing, choking or unsafe positioning, potentially resulting in respiratory illnesses and undernutrition (Calis et al., 2008; Huysentruyt et al., 2020; Manikam and Perman, 2000; Miller, 2019; Sullivan, et al., 2000). Among such children, stunting and wasting were found to be as high as 75 percent and 58 percent, respectively, in low- and middle-income countries (Herrera-Anaya, et al., 2016; Jahan et al., 2019; Johnson et al., 2017; Kakooza-Mwesige et al., 2015; Miller, 2019; Polack et al., 2018; Silva et al., 2017; Wang et al., 2016). These studies report estimates of malnutrition that are much higher than the national averages in the countries where they were conducted (UNICEF, 2019). While these estimates may be confounded by disability, the reported high rates cannot be solely explained by disability-specific altered growth patterns. The vulnerability of children with disabilities is magnified due to their increased risk of loss of family care, neglect, abuse and unsafe feeding practices (such as force feeding and supine feeding) (Maulik and Darmstadt, 2007; Flynn et al., 2019; Berens and Nelson, 2015; Rabaey, 2017).

Despite their high risk of malnutrition, children with disabilities have limited access to quality nutrition services (Groce et al., 2013). Most nutrition programming focuses on preventing prenatal disabilities and disability in children, but rarely addresses the nutrition needs of children with disabilities (Groce et al., 2014).

For example, the widely used Infant and Young Child Feeding Guidelines (WHO, 2003) are designed to meet the needs of typically developing children. They do not offer tangible solutions to caregivers or health workers on how to address feeding challenges among children with disabilities, such as difficulty swallowing and sitting upright for feeding. Training caregivers on simple adjustments to positioning their child during feeding can have a significant impact on author: children's health outcomes (Adams et al., 2011; Howe and Wang, 2013; Rabaey, 2017). Attaining equity and achieving SDG 2[1] will require a paradigm shift – in mindset and action – to reach these children. It will also require the adoption of cost-effective and sustainable solutions that promote equitable access to nutrition interventions.

1 End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Fortunately, there has been a dramatic increase in the availability and uptake of digital technology to address global health challenges, especially since the launch of the SDGs (Novillo-Ortiz et al., 2018). Practically all SDGs have a digital component, and mobile health (or mHealth) apps are particularly prevalent (Marcolino et al., 2018).

However, to the best of our knowledge, none specifically addresses the unique nutrition and feeding needs of children with disabilities. The Global System for Mobile Communications Association's mHealth Tracker (GSMA, 2020) lists more than 300 mHealth products and services around the globe, for instance, but the few apps that are focused on nutrition and feeding are not designed for children with disabilities..

Similarly, the launch of the SDGs created strong momentum for promoting eLearning to broaden equitable access to knowledge and skills (Otto and Becker, 2018). As a result, eLearning courses are now available on a global scale. Many nutrition-related courses are curated by leaders in global health and supporters of disability inclusion, including the SDG Academy (n.d.), the United States Agency for International Development's Global Health eLearning Center (USAID, n.d.) the United Nations Children's Fund (UNICEF) global eLearning hub (UNICEF, n.d.) and Alive and Thrive (n.d.) among others. Yet, to our knowledge, none of the content focuses on adapted nutrition and feeding for children with disabilities.

SPOON,[2] a global non-profit, has been leveraging digital technology to deliver interventions and empower service providers, programme implementers and policymakers in supporting nutrition and feeding for children with disabilities and their caregivers. Currently, SPOON is working closely with local governments and civil society organizations in Zambia, Uganda, Tanzania, China, Vietnam, and Belarus to develop the capacity of their health and social workforce in adapted nutrition and feeding care for children with disabilities; to provide digital tools to facilitate the implementation of nutrition and feeding interventions; and to support the collection of nutrition data on this population. SPOON's programmes are informed by the World Health Organization's guidelines and clinical expertise in disability rehabilitation.

In this article, we call attention to the population we serve, highlight two of our digital solutions – an mHealth app and an eLearning initiative – and share recommendations based on our experience of deploying these solutions in low- and middle-income countries.

USING DIGITAL TECHNOLOGY TO REACH CHILDREN WITH DISABILITIES

While children with disabilities have the same basic health-care needs as all other children, they often require specialized interventions (such as positioning support and adapted growth assessment techniques) not currently provided by nutrition and rehabilitation programmes. While service providers and policymakers voice commitment to children with disabilities and their families, they typically lack the technical skills to support them.

SPOON has identified a need and demand for (1) tools that facilitate the delivery of quality adapted nutrition and feeding care and (2) training that is relevant across sectors and widely available. It has designed an mHealth app called *Count Me In*,[3] now implemented in five countries (Vietnam, China, Zambia, Uganda, and Tanzania), and launched an eLearning initiative in nurturing care for children with disabilities.

COUNT ME IN: TRANSFORMING HEALTH-CARE DELIVERY FOR CHILDREN WITH DISABILITIES

Count Me In is a web-based app that promotes good positioning, safe feeding, skills-building and social development for children with disabilities. It guides caregivers through screening and observations to assess feeding difficulties and generates recommendations on best practices and specialized feeding techniques. The app complements feeding interventions with referrals, growth monitoring, anaemia screening and dietary recommendations. Combining mHealth and artificial intelligence, *Count Me In* enables caregivers to competently perform clinical tasks, such as the assessment of feeding difficulties, the delivery of specialized feeding techniques and the interpretation of growth charts. Specifically, the app:

2 https://www.spoonfoundation.org/

3 http://www.spoonfoundation.org/what-we-do/how-we-help/count-me-in/

- uses sophisticated algorithms to automate triaging and clinical decision-making, including referrals and customized care plans for each child
- improves the accuracy and efficiency of plotting growth charts
- interprets child data and provides timely feedback to caregivers
- generates key nutrition indicators in real time to assist with decision-making and advocacy.

To date, preliminary data on 224 children with disabilities collected through the app by trained health-care workers in residential care institutions or community-based rehabilitation centres show trends towards improved nutritional status (43.6 percent reduction in anaemia and 24.7 percent reduction in wasting) (Miller, 2019).

CATALYSING INCLUSION AND QUALITY CARE FOR CHILDREN WITH DISABILITIES THROUGH ELEARNING

Caregivers' success in ensuring the healthy growth and development of their children is contingent on access to quality care and services. This cannot exist without investment in training and skills-building. SPOON is piloting an eLearning initiative to strengthen the capacity of health-care and child-welfare professionals and programme implementers in adapted nutrition and feeding care, and to support *Count Me In* users with ongoing training.

To date, around 50 health and child-welfare professionals in Uganda, Zambia and Tanzania have completed online training on growth assessment, nutrition interventions and feeding best practices for children with disabilities. This eLearning initiative is timely, as it is meeting the rise in demand for distance learning due to COVID-19. It provides an efficient means of disseminating critical knowledge and skills at a low cost per learner.

RECOMMENDATIONS FOR IMPLEMENTERS

Based on SPOON's experience, we recommend the following considerations when applying mHealth and eLearning approaches in similar contexts:

- Ensure interventions take into account resource availability, cultural norms, language and the wider nutrition and feeding context for children with disabilities.
- Consider users' basic computer skills, access to internet and devices, internet speed, attitudes towards technology and eLearning, and time capacity to participate in these initiatives.
- Use a learning management system that functions in low-bandwidth settings.
- Understand the local laws and regulations relating to data privacy.
- Determine whether and how digital elements need to be blended with non-digital ones.
- Engage disabled persons' organizations and people with disabilities as key partners.
- Continually incorporate user feedback to ensure relevancy and acceptability.
- Include considerations of gender and social norms: ensure all genders are being impacted equitably, adapt tools to the learning needs of all genders, engage family members other than mothers and disaggregate data by gender.
- Advocate for appropriate policy and support so that users can apply their knowledge and skills.
- Emphasize continual learning for caregivers and health professionals.

Implementers should be aware of the following potential constraints and threats to sustainability:

- Delays may be imposed by some governments in response to the overwhelming number of mHealth apps being piloted in their countries (Greeley et al., 2013). Implementers may need to present their app for approval by local digital health authorities.
- There may be assumptions that in-person education holds more benefits. eLearning certificates remain difficult to authenticate and may cause mistrust of training quality.
- The use of technologies and the Internet is not evenly distributed across countries, limiting the full global potential particularly in rural areas (GSMA, 2019).
- Stigma and misinformation about disabilities may be present at any level and should be addressed for learners and programme stakeholders.

CALL TO ACTION

SPOON's experience and preliminary data suggest that the use of digital technology, like mHealth and eLearning, could help provide children with disabilities with essential nutrition and feeding interventions. Technology alone cannot solve these issues, however (Hernandez and Roberts, 2018). Governments and civil society must target children with disabilities specifically if we are to honour our commitment to ensure good health and well-being for all. This means engaging children with disabilities as beneficiaries of digital solutions. As COVID-19 is projected to increase malnutrition while making in-person services inaccessible in many areas (UNICEF, 2020), the global nutrition community must not forget about the millions of children with disabilities. It is time to give them their right to survive, thrive and reach their full potential with dignity.

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ZEINA MAKHOUL/ ZEINA MAKHOUL

A health professional in Zambia counseling a mother on how to safely feed her child with cerebral palsy.

Using cutting-edge technology to end malnutrition

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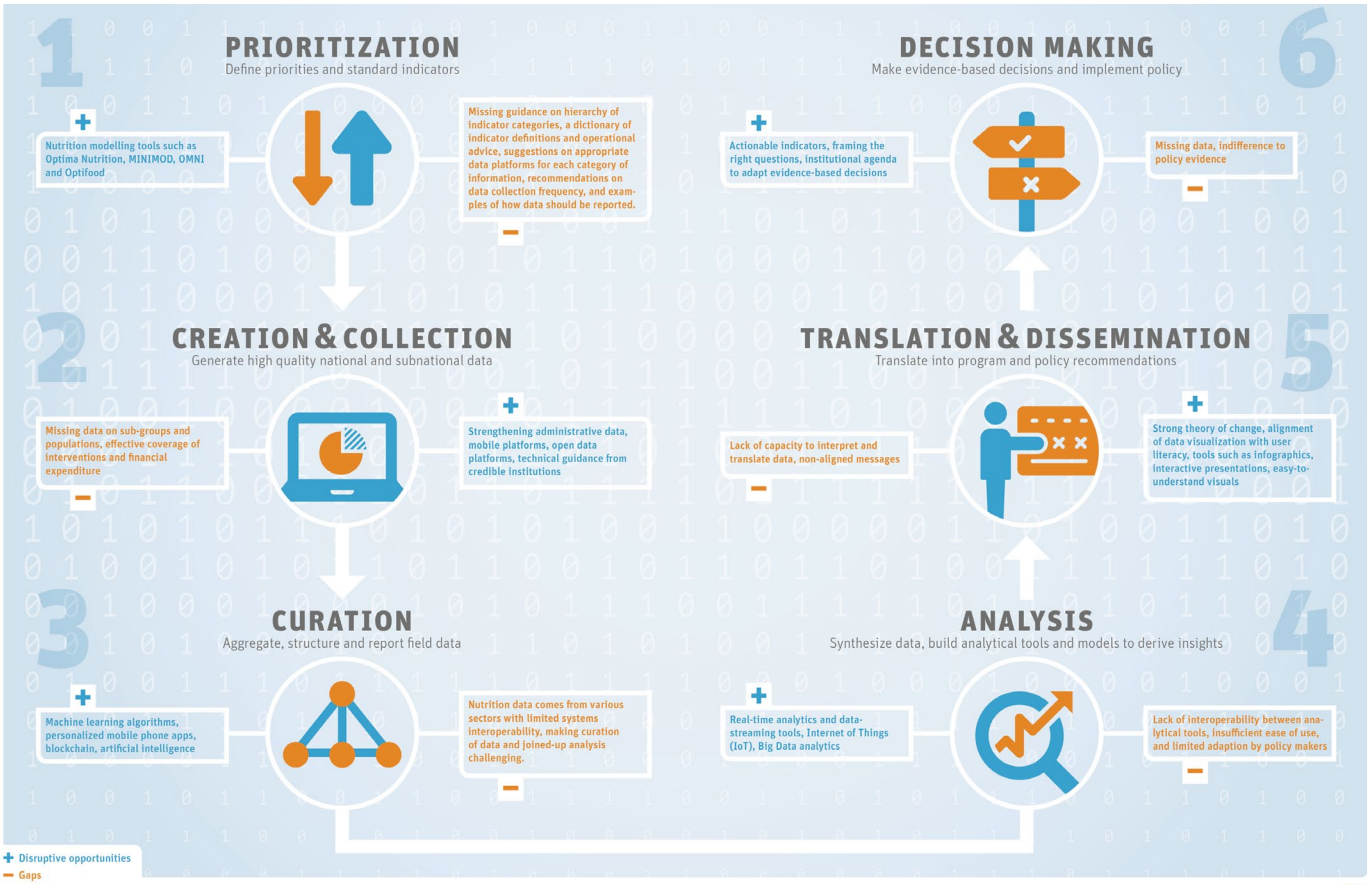
The world is facing a malnutrition crisis. One billion people are hungry, at least 3 billion do not receive sufficient nutrients and more than 2.5 billion consume unhealthy diets (UNICEF, WHO and World Bank, 2018). In addition to its immediate impact on health and society, the COVID-19 pandemic will cause significant short- and long-term disruptions to food systems. This will reduce the availability of nutritious foods, particularly for poor and vulnerable populations, and fuel the prevalence of all forms of malnutrition.

At the same time, we are living in a world that is increasingly data driven. From social media and satellite navigation systems to mobile-phone apps that count calories, robots that fight climate change and governments that forecast future disease outbreaks using Google, data use has transformed our society in unprecedented ways. As the momentum behind the use of data intensifies, the opportunities to avail of it to spark change and drive development are endless. The digital world holds the potential to not only affect the underlying and immediate causes of malnutrition in all its forms, but also its root causes and our ability to address them.

Still, nutrition data remain fragmented and incomplete, particularly in low- and middle-income countries (LMICs), making it difficult for governments, development partners and other stakeholders to access and use them to monitor ongoing efforts and allocate resources. The 2018 Global Nutrition Report affirms that "there are still vast gaps in the data available to help us better understand the nature and extent of malnutrition in all its forms. Many countries do not yet collect the necessary data to fully understand the nature of the burden of malnutrition, diet or indicators of progress" (Development Initiatives, 2018). As we strive to end all forms of malnutrition by 2030, there is an urgent need to harness data to track progress, hold stakeholders accountable and foster rapid collaboration. Being able to collect, analyse and translate nutritional data, therefore, is essential to understanding the challenges and making important decisions to meet global nutrition goals.

The nutrition-data value chain (Figure 1) considers data a value-adding ingredient that not only serves to gauge progress towards nutrition goals, but which is essential to achieving them. This end-to-end systems approach was first proposed by the Data for Decisions to Expand Nutrition Transformation (DataDENT) initiative in 2017 and encompasses multiple links, from the prioritization of what to measure and how, through the collection, curation and analysis of the data and its translation into information and evidence that is widely shared and informs decision-making (DataDENT, 2019). Each link is vital to collect, assess and transform data into action, as well as to build capacity and transform information into sound decisions. Here, we use the data value chain as the organizing framework to discuss the ways in which technologies are changing, how we address malnutrition and to highlight examples of innovations featured in the publication *Data in Nutrition* (Sight and Life, 2019).

Figure 1. THE NUTRITION DATA VALUE CHAIN: GAP AND DISRUPTIVE OPPORTUNITIES



Source: *Sight and Life (2019)*

SIGHT AND LIFE/SAURABH CHATTERJEE

Malnutrition results in the intergenerational transmission of inequity, poverty and poor health and poses a significant barrier to equitable and sustainable social and economic development. The data-collection step in the value chain is, perhaps, the most important and requires the establishment of high-quality national and subnational systems to collect reliable information. Yet, many nutrition issues still lack dependable data. This is the case for micronutrient deficiencies, which are still poorly understood in most countries due to vast data gaps.

To improve data to better understand where micronutrient deficiencies are located and to better target programming and interventions, OpeN-Global was created as an online resource to support the collection of micronutrient status data (OpeN-Global, n.d.). It provides downloadable laboratory standards of practice to LMICs, including details on quality control and accreditation, technical support and fully referenced general information for more than 20 nutrition biomarkers, to support the objective, detailed, accurate and high-quality assessment of nutrition biomarkers normally used in population surveys and research. In the short-term, it has built capacity and fostered collaboration in LMICs to improve quality control and assurance, technical accreditation, investment and trust – leading to more and better data. In the long term, it is expected to enable greater understanding of the specific nutrition challenges of LMIC regions, leading to targeted programmes and policies (Farebrother and Moore, 2019).

Because of the multisectoral nature of nutrition, data come from various sectors that have limited ability to connect in a coordinated manner, thus the curation step of the data value chain is critical to aggregate, structure and report on the data collected. Dalili is an innovative tool that uses smartphone-based data curation to put affordable, nutritious food on the plates of the world's most vulnerable (WFP Innovation Accelerator, n.d.). Dalili ("my guide" in Arabic) is a smartphone app developed by the World Food Programme, together with its innovation accelerator in Munich and retail team in Beirut, that allows anyone in Lebanon to compare the prices of 250 staple foods in local shops using the phone's global positioning function. Users can also compile shopping lists and leave anonymous feedback to help shop owners improve their stores. The app had more than 20 000 users in 2018 and is an important step in empowering families to take control of their own nutrition and health.

Synthesizing, translating and packing data to facilitate action is one of the final and most important steps in the data value-chain approach, as the ability to provide high-quality data on the right indicators at the right time can galvanize decision makers. Data-driven technologies can support the translation of data into action, especially in real time, and are being used to improve nutrition and health outcomes at the individual and global level in unimaginable ways – from nutrition apps that employ machine-learning algorithms to track dietary intake to educational games and web- or media-based digital nutritional education tools.

GeoPoll uses mobile technology to collect nutrition-related data from difficult-to-reach, remote and dangerous locations (GeoPoll, n.d.). Tools including SMS surveys, automated voice calls and web applications collect household and community-level information, track nutrition and dietary habits, and conduct baseline and endline studies. These data are synthesized to provide valuable insights into service delivery, feeding behaviours and project effectiveness. GeoPoll's systems are directly integrated with mobile networks in more than 70 countries and can disseminate surveys to almost any country through voice calls, the GeoPoll mobile app and other means.

In the face of all of these innovations, it is important to note that low-tech administrative data, routinely collected by low-and-middle-income countries, are a goldmine of actionable information, with the potential benefits of timeliness and full coverage of programme participants. However, governments need to focus their efforts on improving the quality of administrative data. A systematic strengthening of data-collection procedures can produce accurate and actionable information. This includes intensive training of actors across tiers, reviews of existing technological equipment against ideal requirements and the systematic triangulation of collected data through independent checks. Consistent real-time administrative data can help diagnose immediate problem areas to better inform policy and programme interventions targeting nutrition outcomes.

These are a few illustrative examples of the power of data for nutrition and how innovations across the data value chain can impact real change. Challenges exist at each link in the nutrition-data value chain, from prioritization to analysis, which currently fails to capture the complex, multisectoral causes of and responses to malnutrition. However, new technologies offer the potential to strengthen nutrition programmes and improve outcomes.

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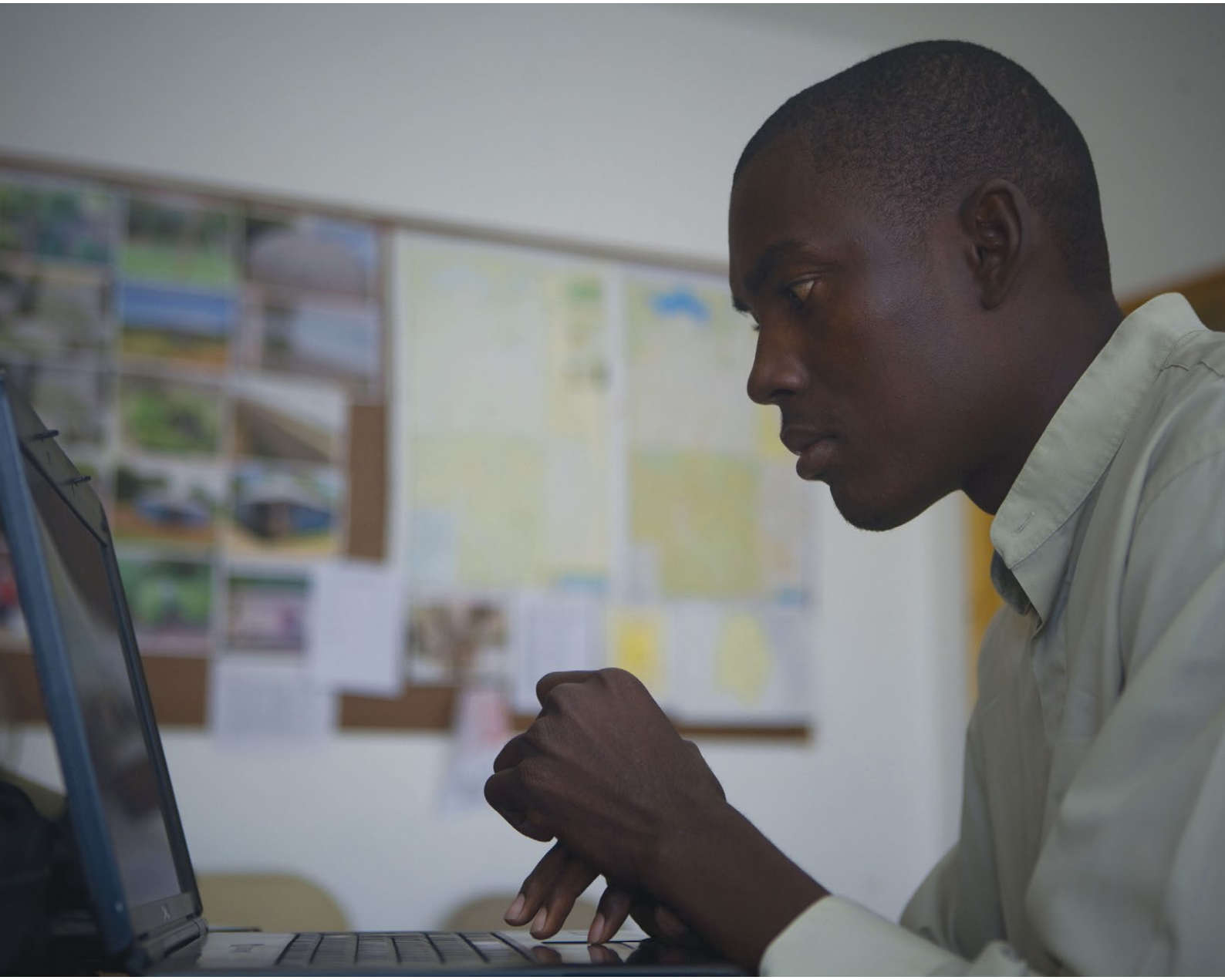

FAO/LUCA TOMASSINI

Improving nutrition and health data to and from remote regions

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INTRODUCTION

There is a real possibility, particularly in sub-Saharan Africa, that the sustainable development targets on nutrition may not be achieved. While the global prevalence of undernourishment has remained slightly below 11 percent since 2015, in Africa, hunger is increasing in almost all subregions (FAO et al., 2019). Sub-Saharan Africa has the highest prevalence of undernourishment globally, at 22.8 percent, equivalent to 239 million people (FAO et al., 2019). It is home to 27 of the 41 countries globally that have high rates of all three forms of malnutrition – overweight, micronutrient deficiency and stunting (Development Initiatives, 2018). More than 40 percent of stunted children live in Africa, and sub-Saharan Africa is the only region in the world to have seen an increase in the number of stunted children over the last two decades (UNICEF, WHO and World Bank Group, 2020).

Sub-Saharan Africa is not only experiencing high malnutrition rates, but many regions also lack the current, accurate and reliable data on nutrition and health that could help to forge effective solutions to reducing malnutrition (Development Initiatives, 2018). Such data are critical to determining if policies and interventions are working and to improving them.

There are some nationally representative sources of household and individual nutrition and health data, such as the United States Agency for International Development's Demographic and Health Surveys (DHS)[1] and the United Nations Children's Fund's (UNICEF) Multiple Indicator Cluster Surveys,[2] but these are rare. When they do exist, however, they are commonly cross-sectional and infrequently collected, as they are extremely expensive. Subnational surveys, such as those conducted to assess humanitarian interventions, are rarely representative, so are difficult to use beyond their immediate goals or to merge with each other to develop broader databases. Other sources of information that are common in more affluent areas, such as the administrative data collected when interacting with public services, are also scarce in remote and poor regions, where access to public services is limited.

1 https://dhsprogram.com/data/
2 https://mics.unicef.org/

The resulting infrequent household-level data can seriously misrepresent the nature of shocks, coping strategies, seasonality and nutrition-security status of individuals within households, with implications for how practitioners and policymakers assess conditions, allocate resources and judge the impact of interventions aimed at improving welfare. It has long been acknowledged that point observations of households do not accurately characterize the dynamic reality of their members and this has been highlighted in a number of recent papers.

For example, Brown, Ravallion and de Walle (2019) find that many underweight women and malnourished children in Africa live in households that are not among the poorest, while Bevis, Naschold and Rao (2019) find that the seasonal nutritional dynamics are heterogenous across individuals within households.

In addition to their high cost and often inaccurate representation of the nutritional reality of individuals and populations, common methods for collecting data in sub-Saharan Africa are often extractive. The data are recorded, sent out of the community and anonymized without providing any direct benefit to those being surveyed and at risk of or suffering from malnutrition, for example, by providing nutritional advice or nutrition support tailored to a participant's responses.[3] In a few cases, a surveyed community may receive a presentation on findings from a development project, or a government may reallocate resources in response to the information collected. However, even then, there is little effort to ensure that the survey respondents benefit directly from the data they provide.

At the same time, the nutrition community has identified education and behavioural change as cornerstones to improving nutrition, while research has shown that linking self-tracking with tailored advice can be an effective method of improving behaviour and impacting health indicators (Mummah et al., 2017; Payne et al., 2015; Sternfeld et al., 2009; Sullivan and Lachman, 2017). The current norms associated with data-collection in development settings neglect an important opportunity to help improve health and nutrition by providing respondents with information on their progress against benchmarks.

There have been several efforts to improve the availability of health and nutritional data and/or reduce the cost of collection. In lower-income settings, most efforts are focused on standardizing and improving the quality of existing methods (for example, the DHS, the World Bank's Living Standards Measurement Survey[4] and the inter-agency Standardized Monitoring and Assessment of Relief and Transitions, or SMART initiative).[5] However, these exercises continue to rely on enumerators for data-collection, which are too expensive for the higher-frequency individual-level surveys required to accurately track health and nutrition dynamics. In higher-income settings, firms and researchers are using browser- or smartphone-based applications that simultaneously collect, track and return information to the user at little to no cost to them. Indeed, such applications can be used to deliver customized messaging and recommendations in response to information recorded by the user, which, as mentioned, have been shown to generate positive behavioural changes in some settings. However, these tools generally require internet connectivity at the time of data-collection and depend on literacy, both of which make them unsuitable for remote environments in low-income countries (Bell et al., 2017).

Unless approaches to collecting nutrition and health data – especially for hard-to-reach communities – become less expensive or users invest more heavily in data-collection, inadequate data will continue to impede the efforts of governments and development practitioners to effectively monitor nutrition-related catastrophes or assess the performance of nutrition and health programmes. Furthermore, without tools for tracking individual performance, caregivers may not be able to accurately assess their own performance against recommendations provided by nutritionists and programme agents. Ultimately, this lack of data will determine how well we will be able to achieve global nutrition and health targets.

3 There is one exception: there is an ethical norm practiced by many survey teams and ethics committees to ensure that any participating child found to be suffering from malnutrition be provided with the means to access appropriate medical attention.

4 http://surveys.worldbank.org

5 https://smartmethodology.org/about-smart/

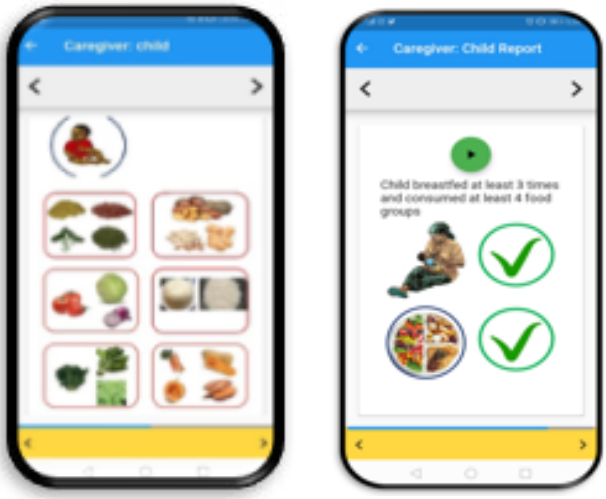
PROPOSED SOLUTION

A team of researchers at the International Livestock Research Institute (ILRI) and the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) have partnered with 190 women and 22 community health volunteers (CHVs) in rural Samburu County, Kenya, to tackle the health information gap faced by policymakers, researchers and individuals interested in tracking the consumption and health information of caregivers and their children at high frequency, over time.

Our goals are to reduce the cost of collecting and disseminating information in remote regions, to improve the nutritional and health data available about and for pastoral and other isolated populations and to develop a methodology for responsive, high-frequency data-collection that will contribute to better health and nutrition policies and interventions. To this end, we have developed a smartphone-accessible health information tool for caregivers of young children in remote regions. The smartphone application (app) – called Mbiotisho, which roughly translates as "our health/nutrition" in the Samburu language – uses a simple audio- and icon-based interface to help the caregivers, many of whom are illiterate and have no experience of smartphones, report their own and their children's consumption and health status. The caregivers, in turn, receive reports on status and trends in the information they report, along with recommendations based on those reports.

Reporting is undertaken by the caregivers on themselves and/or their children as much or as little as they like. The caregiver begins by selecting an icon indicating who she is reporting on and then faces a sequence of questions with related response options, all based on audio messaging in the local language and sets of icons that were identified and agreed by researchers and caregivers. Through the app, the caregivers can record information for the previous 24 hours on: the consumption of foods from 16 food groups (Kennedy, Ballard and Dop, 2013; WHO, 2008); food security as captured by the reduced coping strategy index (Maxwell and Caldwell, 2008); incidence of clinical symptoms, such as cough, diarrhoea and cough; health care-seeking behaviour; and, in the case of children, source and treatment of water and mid-upper arm circumference (MUAC). The caregivers were trained on how to report on each of these indicators and, in the case of MUAC, how to collect a photo of the reading for verification. The left panel in Figure 1 provides an example of the app interface used by caregivers to report the food groups consumed by an index child over the previous 24 hours.

Figure 1. EXAMPLE OF PROCESSES USED IN THE MBIOTISHO CAREGIVER APPLICATION



Note:

The left panel shows the process for collecting 24-hour recall of consumption by food group for the child. The right panel is an example of feedback given to a caregiver with a child aged 12–24 months.

Source: *ILRI and FANRPAN*

In addition to being stored on the device until it can be synced to the server and accessed remotely, the information recorded by the caregivers is also processed directly on the caregiver's mobile device, which then provides customized recommendations to the caregiver through a series of images and pre-recorded messaging. One such audio message reminds caregivers of children between 12 and 24 months of the importance of complementary feeding and compares the caregiver's reports on child feeding with recommended practices. The right-hand panel of Figure 1 provides an example of the feedback a caregiver might receive.

Another recommendation illustrates the level and trends in the child's MUAC records and instructs the caregiver to contact a CHV if the MUAC falls below the 125mm threshold for moderate acute malnutrition. We hope that caregivers will use this information to benefit themselves and their children, either by adjusting their behaviour or by contacting their local CHV when the child's health is in jeopardy.

IMPLEMENTATION

The project obtained research approvals from Kenya's National Commission for Science, Technology and Innovation and ILRI's Institutional Research Ethics Committee. Pre-piloting was performed with CHVs and caregivers in Lolmolog, Kenya, to test the feasibility of the processes, improve the user interface and develop a training curriculum. Over three weeks in July and August 2019, we tested and iterated and retested every aspect of the app. Our main finding was that caregivers could and would participate in the activities, at least in the short term, and that they were enthusiastic about the process, especially the tracking features.

The 12-month pilot project was launched on 17 October 2019. Its primary objective is to determine whether caregivers will collect information reliably and accurately over the period. To assess the accuracy of the caregiver-collected data, we will compare it with data collected by CHVs on the same individuals at the same time. A secondary objective is to test if the caregivers adjust their behaviour in response to the tracking and recommendations provided by the tool. To provide an empirical strategy for causal inference, we launched the tracking and recommendation features of the application one month after data-collection started.

The pilot project was launched in four community health units (CHUs) in the pastoral region of Samburu County, selected to provide variation in remoteness and access to infrastructure, caregiver literacy levels, nutritional status and experience with mobile phones. The community health extension worker of each CHU selected five CHVs to participate in the study. Each CHV then provided a roster of caregivers that they supported and that met the project's eligibility criteria: participants needed to be of childbearing age and the primary caregiver of at least one child between 5 and 47 months of age at the time of selection.

For CHVs with sufficient rosters, five caregivers with children aged less than 24 months and four caregivers with children over 24 months old were randomly selected to participate. For about half of the CHVs, their caseload contained fewer eligible caregivers than our target number of caregivers per CHV. In those cases, the extension worker helped the CHVs to identify additional caregivers within their area. Two additional CHVs from the largest CHU, each with five caregivers, were added to the sample by the same process, in response to our concern that two of the CHVs there might not perform well.

In total, all 190 caregivers and 22 CHVs were invited to and participated in training on the project's objectives, phone use and how to use the Mbiotisho app. All participants were provided with phones, small solar chargers for them and monthly mobile-phone data bundles for submitting records. The caregivers were invited to participate as much or as little as they liked and are paid KES 20 (about USD 0.20) per submission. The app limits the caregivers' contributions to a maximum of once every 24 hours for themselves and their index child.

The CHVs' project activities were developed to integrate easily into their existing monthly work schedule, during which they visit each caregiver in their caseload and log the caregiver's pregnancy status, attendance at antenatal care, child MUAC and child immunization. They can include nutrition education. We also asked the CHVs to conduct a survey – the benchmark data – from the participants during those monthly visits and to provide any technical

support the caregivers needed over the duration of the project. In most cases, the technical support entails helping the caregiver deal with the quirks of smartphones, such as accepting or rejecting app updates, but can also include responding to questions the caregiver has on the intention behind a question, or even reinstalling the app if the phone has been accidentally reset or the app uninstalled. The CHVs are paid a stipend of KES 3 000 (USD 30) per month by the project for this additional work.

After the training sessions were completed, the CHVs asked each caregiver if they consented to participate in the study. All 190 consented and were enrolled in the study by the CHVs, who then collected basic demographic information. At his point, one caregiver dropped out of the study. The participating caregivers range from 15 to 61 years of age and most have little or no formal education, are illiterate and have no experience of smartphones (Table 1). The children participating in the programme are nearly two years of age, on average, but there were participants as young as 5 months and as old as 47 months at the time of registration.[6]

Table 1. DEMOGRAPHIC COMPOSITION OF THE STUDY PARTICIPANTS

	No.	Mean	Standard deviation	Minimum	Maximum
Caregiver					
Age (years)	189	27.2	7.5	15	61
Female	189	1.00			
Any formal education	189	48%			
Can read	189	48%			
Has used a smartphone	189	11%			
Index child					
Age (months)	189	20.7	10.8	5	47
Female	189	51%			
In a feeding program	189	6%			

Source: *ILRI and FANRPAN.*

Table 2. SUMMARY STATISTICS ON CONSUMPTION FROM NOVEMBER-DECEMBER 2019 CHECK-UPS

	No.	Obs.	Mean	Std. dev.	Min.	Std. dev.
Caregiver (N=182)						
Minimum Dietary Diversity for Women (MDD-W)[A]	173	248	3.10	1.37	1	7
MDD-W ≥ 5[B]	173	248	15%			
Reduced Coping Strategy Index (rCSI)[C]	173	248	4.87	3.08	0	8
Number of meals in the last 24 hours	173	248	3.70	1.45	0	9
Child						
Minimum Dietary Diversity Score (MDDS, 6-24 months)[D]	168	236	2.66	1.46	0	6
MDDS ≥ 4 (6-24 months)[E]	168	236	23%			
Reduced Coping Strategy Index (rCSI))[C]	168	236	2.37	2.14	0	5
Number of meals in the last 24 hours (age ≥12 months)	168	236	3.32	1.63	0	9
Child is nursing (age <24 months)	99	139	78%			
Child is nursing (age <12 months)	38	57	100%			

Notes: (a) *MDD-W is calculated by summing the number of food groups consumed in the previous 24 hours from a menu of 10 food groups. It has a range of 0-10. See FAO and FHI 360 (2016) for more information on the index, its construction and objectives.* (b) *It is recommended that women maintain a MDDS of five or greater (FAO and FHI 360, 2016).* (c) *rCSI is calculated by summing the weighted responses to a set of five questions on coping strategies utilized by the household in the last 24 hours. It has a range of 0-50. See Maxwell and Caldwell (2008) for more information on the five questions, the weights used and the characteristics of the index.* (d) *MDDS is calculated by summing the number of food groups consumed in the last 24 hours from a menu of seven food groups. It has a range of 0-7. See WHO (2008) for more information on the index, its construction and objectives.* (e) *It is recommended that children maintain a MDDS of four or greater (WHO, 2008).*

Source: *ILRI and FANRPAN.*

6 These figures reflect our sampling frame, which included children that would be between 6 and 48 months at the start of data collection.

While the data-collection component of the project had only been running for two months as of 1 January 2020, to provide some indication of the data that will be collected over the remainder of the pilot, we include summary statistics from the initial CHV check-ups that took place in November and December 2019 (Table 2).

Only 15 percent of women and 19 percent of children in the survey sample meet the recommended thresholds for MDD-W and MDDS, respectively, indicating lower-than-recommended dietary diversity for both groups. At the same time, 100 percent of children under 12 months and 78 percent of children under 24 months continue to breastfeed, as is recommended.

DISCUSSION AND CONCLUSION

Although it is too early in the study to assess the data quality or behavioural responses to the tracking features, the caregivers are successfully using the tool to collect, submit and receive information. In December 2019, the first full month after training, caregivers completed and submitted 1 607 caregiver check-ups, 1 573 child check-ups and 322 child MUAC check-ups. The study will continue with data-collection by both caregivers and CHVs and we will soon begin a rigorous comparison of the two sets of data.

Beyond the assessment of data quality, we aim to learn about and provide guidance on the appropriate frequency for collecting specific types of data and to understand data-collection errors that may result from caregiver-collected data. For example, MUAC should be recorded at a frequency that reflects its dynamics, but also frequently enough to control for the errors introduced by the caregivers in their collection and recording process. What that frequency is will be identified by comparing the monthly data collected by the CHVs with the higher-frequency data collected by the caregivers. We will also explore how best to dynamically adjust frequency, question sequence and information provided to caregivers in response to their records and to reflect sudden changes in indicators, environmental shocks or outbreaks of common diseases (such as cholera, malaria and COVID-19).

This pilot phase will be followed by validation through further testing at two additional sites in Kenya and one other country. These additional locations will provide information on the tool's applicability in different food environments and cultures. The comparison will also expand beyond the current scope to include a cost-comparison with other conventional methods of data-collection, a critical factor for upscaling.

An important feature of the tool is that it provides tracking and tailored recommendations to the caregiver in near-real time, potentially helping her make better consumption decisions. Indeed, requests for additional functionality in this regard have constituted a considerable portion of comments received from the caregivers to date. There is a possibility of extending the tailored advice to include more sophisticated logic and related recommendations. Furthermore, because the data are often uploaded soon after collection, the tool could be used by programmes to facilitate the provision of appropriate care and support to the households in response to acute events. The availability of the data in near-real time could expedite programmatic response by both humanitarian and government agencies. Such efforts to upscale the tool will be conditional on the results of the assessments of data quality.

Ultimately, we see the use of this tool allowing communities to take responsibility for their nutrition and health outcomes, with government and non-state agencies providing the necessary support. Its use could be extended to other community-based development initiatives beyond nutrition and health, for example, early-warning systems, where near-real-time data-collection and dissemination are important elements.

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WATSON LEPARIYO

Insights

Harnessing AI to achieve healthy and sustainable food systems

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The quest for healthy diets, particularly from sustainable food systems, is one of the greatest challenges of our time. Dietary risk factors contribute to one in five deaths globally and are a leading cause of many chronic conditions, including obesity, type 2 diabetes, numerous cancers, cardiovascular diseases, mental-health issues and poor dental health (Micha et al., 2017; WHO, 2018a). Food is inextricably linked with environmental degradation, accounting for between 33 percent and 39 percent of the food-related environmental footprint in Australia, for example (Hendrie et al., 2016). Progress in shifting our global food system to a healthier and more sustainable model has been limited. The recent Lancet Commission on the Global Syndemic of Obesity, Undernutrition, and Climate Change has attributed this patchy progress to policy inertia due to inadequate political leadership and governance, powerful opposition from large multi- and transnational food corporations and a lack of civil mobilization (Swinburn et al., 2019).

With challenges come opportunities. We live in an age of rapid and exponential technological change. Digitalization, interoperable data, the Internet of Things and artificial intelligence (AI) are influencing our lives in ways once unimaginable. Rapid advances in health technologies, computing power and the capture and analysis of "big data" are enabling a new era of risk surveillance and data analytics. In this article, we illustrate how the usefulness of AI can be harnessed in population food and nutrition research, policy and practice to produce more precise, potentially more effective and lower-cost (1) monitoring and accountability, (2) information synthesis and (3) implementation science. Our examples are by no means exhaustive, but illustrate how the field of population nutrition can be significantly advanced using AI, ultimately promoting and supporting stronger and more comprehensive action to shift population diets towards healthier and more sustainable models.

ARTIFICIAL INTELLIGENCE

AI is a general term to describe the use of computers to model behaviours associated with human intelligence (such as understanding the environment, perceiving a situation, solving problems and learning new tasks) in an autonomous or semi-autonomous manner. Although they have existed since the 1950s, AI technologies are fast becoming more accessible, affordable and more user-friendly than ever before owing to advances in computing platforms. This has prompted their widespread use in various disciplines. Still, uptake in population health has been relatively slow (Lavigne et al., 2019).

It is impossible to distil the principles and technological capabilities of AI into a short article. Therefore, we focus here on machine learning – the application of a set of AI-based algorithms that can characterize, adapt, learn, predict and analyse data. At the simplest level, machine learning uses the same regression models used by epidemiologists (linear and logistic regressions) for predictive purposes. At the other end of the machine-learning spectrum are deep neural networks (DNNs) – a type of machine learning that simulates a network of neurons within the human brain, whereby information processing takes place over thousands of hierarchical layers in a bid to analyse and make sense of large amounts of data.

MONITORING AND ACCOUNTABILITY FOR NUTRITION

While international best-practice methods exist for the monitoring of nutrition-related risk factors and outcomes, food environments, policies and industry practices, a dearth of funding has restricted the pace, breadth and sustainability of data collection (Swinburn et al., 2019). Furthermore, this approach to monitoring is based on a paradigm established prior to the common use of AI techniques, so is silent on the potential of these techniques or the appropriate ways in which they might be used. Take the advertising of unhealthy food to children as an example. With the rise of digital and social-media platforms, children are at risk of exposure to high volumes of marketing, which is more personalized and more targeted than ever before. This is achieved by using machine-learning algorithms that can capture and learn users' preferences through their digital devices. Unequivocal evidence shows that marketing unhealthy foods to children adversely influences their attitudes and behaviour over their lifetimes (Smith et al., 2019).

The World Health Organization (WHO) recently identified a critical need for tools to monitor children's exposure to unhealthy food advertising globally (Allender et al., 2020; WHO, 2018b), yet no such tools currently exist. One key challenge is the highly complex and ethically sensitive task of collecting data from children as they go about their daily lives. Deep-learning algorithms offer an alternative that could revolutionize the way in which unhealthy advertising to children is captured and monitored.

Specifically, region-based convolutional neural networks (R-CNNs) and other related DNNs can automatically process, identify and classify relevant advertising images from either static displays or video clips. The R-CNNs are state-of-the-art models, widely known to be useful and effective in analysing visual imagery, especially when multiple objects are embedded in the visual field, which is typically the case for digital advertisements. R-CNNs can recognize objects even when the visual fields of multiple objects are overlapping and/or occluded. A further advantage of this approach is that it can filter out user-specific and proprietary information, as it can be employed to analyse specific regions of interest in an image. Thus, no personal information is captured and recorded – addressing a key ethical challenge in this area of research.

Other types of DNN, such as deep recurrent neural networks (DRNNs), can also be used to process, extract and analyse relevant advertising information from video clips. In general, the training of these deep-learning algorithms requires a large and diverse image library that represents generic product identification (for example, a burger, or common brand-specific products and logos). Web-based image-scraping methods through machine-learning algorithms, supplemented by crowdsourcing data platforms, can be used to generate the large and diverse image library required to train the algorithms to identify advertising imagery.

Turning to agriculture, the development of climate-resilient foods and crops will be essential to feed the world's population in future. AI-driven data analytics are showing great promise for monitoring subtle differences in plants' genetic adaptation to climate change, so that sustainable crops can underpin future agricultural production (Streich et al., 2020).

INFORMATION SYNTHESIS AND ANALYSIS

The scale of the information and data available today is unprecedented. For example, millions of tweets are generated every day on Twitter. We also live in an age in which most aspects of life and business are digitalized, giving us a wealth of information at our fingertips. Making sense of this trove of information in a way that is both useful and timely is essential to informed decision-making.

Another application of machine learning is the use of intelligent natural language processing tools and algorithms to process unstructured text (and/or human language) and make sense of it. This is achieved with machine-learning algorithms that understand and learn the hierarchical structure of language, part-of-speech tagging and language semantics. Although used sparingly in population nutrition research to date, the potential for intelligent natural language processing tools to substantially transform laborious, resource-intensive methods of text synthesis and analysis is considerable.

This includes, for example, the automation of systematic literature reviews (Marshall and Wallace, 2019), large-scale policy-framing analyses of media articles or government proceedings (Hamad et al., 2015; Marín and García, 2018) and the interpretation of thousands or millions of social-media posts to gauge public opinion or corporate framing of nutrition-related issues (Le and Nguyen, 2015). Automated web-based data-crawling, synthesis and analysis through machine-learning algorithms may also be explored to replace the manual tracking of corporate political activity in the food industry, with updates in near-real-time, creating a rapid accountability mechanism for "big food" companies.

Real-time synthesis and analysis of "big data" is also increasingly employed in agriculture to maximize productivity while minimizing environmental impacts (Liakos et al., 2018). This process, known as precision farming (or digital agriculture), involves capture and analysis of operations data (crops, soils, weather and machinery) and integration of machine learning, "big data" technologies and high-performance computing to automate and optimize crop management (yield prediction, disease detection, weed detection, crop quality), livestock management (animal welfare, livestock production efficiency, water management) and soil management (temperature, moisture, condition). However, a greater understanding of how the results of these types of data analyses can successfully influence the decision-making process is required (Liakos et al., 2018).

IMPLEMENTATION SCIENCE

Implementation science can be defined as the scientific study of methods to enhance the systematic acquisition and use of evidence in policy and practice to optimize population health (Braithwaite et al., 2018). It is widely recognized that healthy and sustainable food systems will only be achieved with comprehensive, multi-strategy, multi-target actions. Therefore, systems thinking, along with tools and techniques informed by systems science, are increasingly being used by implementation scientists to co-create a range of effective solutions with systems stakeholders. The goal is multiple changes at multiple systemic levels, producing synergistic effects. The challenge lies in optimizing the entire system of interventions by understanding the most effective intervention components and feeding this back to stakeholders in a timely manner.

Augmented decision-making, using machine-learning techniques and Bayesian multi-armed bandit algorithms,[1] has recently been used to acquire rapid evidence of the effectiveness of general practitioner-prescribed physical-activity interventions from a set of eight different possible interventions (Allender et al., 2020). This rapid generation and translation of evidence using machine-learning techniques allowed the identification of the two most effective strategies just seven weeks after the algorithm-based assignment of strategies. Other multi-criteria decision-making models using fuzzy logic[2] can also be used to evaluate interventions and rapidly translate evidence into policy and practice.

However, when applying these types of augmented decision-making tools to population nutrition research, additional challenges arise, such as the collection of clear, measurable outcomes to inform intervention effectiveness. An accurate understanding of intervention effectiveness is essential for the translation and adoption of evidence-based practices, yet nutrition research has long suffered from the collection and use of biased food intake data. The collection of such data may be improved over time using AI technologies (supporting not only implementation science through more accurate measures of intervention effectiveness, but also the routine monitoring of population dietary intake). For example, the recording of mealtimes and application of machine-learning algorithms for image capture, processing and analysis may improve the accuracy and ease the participant burden of dietary intake data collection.

1 Also known as Thompson sampling, or randomized probability matching

2 Fuzzy logic is an approach to computing based on "degrees of truth" rather than the "true or false" (1 or 0) Boolean logic on which the modern computer is based.

A WORD OF CAUTION

As the public health community considers and cautiously adopts and applies AI, "big food" is also harnessing its potential. History tells us that food corporations will remain ahead of the curve when it comes to the novel application of AI and use it to steer populations towards profitable, unhealthy food consumption. Already, the food industry is using AI to tap into customer behaviour, location and views to powerfully influence food perceptions, purchasing and consumption in ways once unimaginable (Backholer et al., forthcoming).

Furthermore, while great strides can be made in applying AI methodologies to solve and optimize complex population nutrition research questions, their use and application is not without limitations. It is important to remember that the quality of outputs depends on the quality of inputs; biased data will result in biased outcomes. Methods to improve data collection and ensure the use of quality data (both big and small) will be important. This is why the topics of machine learning and "big data" are often discussed in parallel. The potential for AI in population nutrition may also inadvertently serve to widen inequities, both between and within countries, through uneven access to the technology and use of biased data.

CONCLUSION

The use of innovative AI tools is required to push population nutrition research and action beyond current boundaries. The potential of AI in the field of population nutrition science will continue to evolve apace, so we must be ready to harness its potential to garner more effective and equitable action with a view to healthier diets from sustainable food systems globally.

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How digital technology is transforming the food retail landscape

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INTRODUCTION

Digital technologies are electronic tools, systems, devices and resources that generate, store or process data (GeSI and Deloitte, 2019). These technologies have a profound impact on the way we grow, distribute, market and purchase foods at local, national and global levels (Jouanjean, 2019). Countries need to create healthy and safe diets and resilient food systems to address malnutrition in all its forms to achieve the 2030 Sustainable Development Goal Agenda (Sachs et al., 2019). Retailers, supermarkets and chain restaurants are powerful agrifood-system stakeholders that use digital technologies and digital marketing strategies to make food supply chains safe, healthy, efficient and sustainable. They also influence the availability and pricing of products, improve efficiency to reduce food loss and food waste and broaden the array of healthy and affordable choices available to enhance people's diet quality and health (Pulker et al., 2018; Kraak et al., 2019a; Renda, 2019).

However, many transnational food retailers and chain restaurants also produce and market a large proportion of highly processed, inexpensive and convenient packaged food and beverage products and menu items purchased by people in high-, middle- and low-income countries. These energy-dense and nutrient-poor products and meals contain excessive energy, fat, added sugars and sodium that contribute to poor-quality diets, linked to undernutrition, obesity and diet-related non-communicable diseases (Baker and Friel, 2016; Kraak et al., 2019a; Monteiro et al., 2013; Popkin et al., 2020; Vandevijvere et al., 2019).

Consumers choose online food shopping and restaurant delivery services for various reasons. In the United States of America, people report using online food-delivery (OFD) services because "they do not feel like cooking at home" or to "save time from cooking or cleaning" (Shoup, 2019). Malaysian shoppers are more likely to use online restaurant services, motivated by convenience, saving time, competitive pricing, pleasure and prior online purchasing experiences (Yeow et al., 2017). In Viet Nam, women are more likely to use the internet to search for food products; their purchases are motivated by convenience and price (Kim Dang et al., 2018). Research has shown that online grocery shopping could increase unhealthy choices because customers purchase primarily processed foods and are less willing to purchase fresh produce online (Jilcott Pitts et al., 2018).

This paper examines digital technology trends that are influencing the current and future business practices of the food retail landscape, including transnational grocery stores and chain restaurants. It describes trends in online food sales and meal delivery, and presents ethical concerns related to the use of digital technology in the food retail sector. It concludes with examples of how food-system stakeholders are using digital technology to support healthy and sustainable diets, providing some insights into how the COVID-19 pandemic has transformed the food retail sector.

DIGITAL TECHNOLOGY TRENDS IN THE FOOD RETAIL SECTOR

Digital technologies influence every sector of national and global economies, including agriculture (for example, precision agriculture, drones and blockchain tracing); food and beverage manufacturing (robotics); food retail and restaurants (e-commerce); finance (e-payments); and media and entertainment (social networks) (Sachs et al., 2019). Digital technologies are transforming the in-store, restaurant and online food and beverage retail environments in most high-income countries by giving customers the choice of

ordering and acquiring foods and meals in new ways based on their preferences, income and time constraints (FMI and Kurt Salmon, 2017). People can purchase groceries at traditional bricks-and-mortar stores, order and eat on the premises of a chain or independent restaurant, purchase and consume their meals in micro food halls that provide communal dining spaces, eat what they cook in test kitchens that offer nutrition and cooking classes, or collect their orders at drive-through locations. Customers can also order groceries, meal kits, take-out or takeaway meals online that are delivered to their home or office by third-party OFD companies (FMI and Kurt Salmon, 2017) or self-driving autonomous vehicles (Digital Commerce 360, 2019).

In many high- and middle-income countries (such as Australia, Canada, China, Germany, Hong Kong, India, the United Kingdom and United States), transnational chain restaurants and food retailers have digitalized the ordering and payment process to bridge the in-store and online transaction experience (Begley et al., 2020; Deloitte, 2017; Episerver, 2019). Digital technologies provide an intuitive, easy, cashless and efficient e-commerce process, whereby customers can use self-order kiosks and digital touchscreens to place orders for groceries or meals (Barrett, 2019; Episerver, 2019). These systems use biometric data collected by facial- or voice-recognition software to confirm a customer's identity, to store information about preferred payment methods and previous orders and to allow automatic purchases to be deducted from a credit card stored on the customer's mobile device (Barrett, 2019; Episerver, 2019; Hawkins, 2017; Yaffe-Bellany, 2019).

Transnational chain restaurants (such as McDonald's, Subway and KFC) and leading global retailers (such as Amazon, Costco and Walmart) engage in OFD and e-commerce. Restaurants are using digital technologies including personal computers, digital and mobile-phone applications (apps), 4G and 5G wireless networks, and online security systems to improve their efficiency and connect with customers (DiPietro, 2017). Restaurant chains are also using artificial intelligence (AI)-enabled systems, including personal digital assistants (such as Apple's Siri and Amazon's Alexa), which employ algorithmic nudging to automate, predict and personalize customer choices based on age, gender, mood, order history, time of day, weather and popular items sold (Barrett, 2019; Episerver, 2019; Hawkins, 2017; McKinsey & Company, 2019; Yaffe-Bellany, 2019).

Retailers are using the online experience to optimize search terms and website content, provide attractive images, offer promotional coupons that ensure the availability and speedy delivery of products to shoppers (Askew, 2018). An AI-enabled payment platform provides a "unified shopping experience" for customers. Retailers and restaurants in China are supported by technology firms, such as Alibaba, which has invested in facial-recognition start-up companies that scan customers' faces when making purchases. This information is linked to a government and corporate digital surveillance system used to monitor the computer activities, behaviours and data content of Chinese citizens (Wong, 2018).

Trends in online food sales and meal delivery services

During the 1990s, major grocery chains, including Walmart and Kroger, began to transform the design and service of their supermarkets for the future (Begley et al., 2020). In 2019, the online grocery market in the United States generated sales of USD–28.7 billion and sales are forecast to reach nearly USD–60 billion by 2023 (Conway, 2020). Table 1 shows global trends. Transnational retailers that have expanded into online grocery shopping include AmazonFresh, FreshDirect, Instacart, NetGrocer, Safeway and Walmart (Conway, 2020). Many leading retailers, such as Albertsons, Kroger, Target and Walmart, are using less costly strategies to compete with Amazon, including automated grocery-picking robotics, e-commerce loyalty programmes that send tailored coupons and promotions to customers, cashier-less stores, voice-enabled and personal shopping, and same-day online grocery shopping with in-store pick-up or OFD services (Begley et al., 2020; Deloitte, 2019).

A 2019 evaluation of the e-commerce marketing strategies used by six US food retailers (Amazon Prime Now, FreshDirect, Peapod, Safeway, Target and Walmart Grocery) found that a substantial percentage of online promotions (29–72 percent), email promotions (63–100 percent) and online product searches by Americans (47–73 percent) were for highly processed, energy-dense and nutrient-poor food and beverage products. The quality of fresh produce ordered online varied substantially from retailer to retailer (McCarthy et al., 2020).

Table 1. TOP 10 GLOBAL CONSUMER GOODS AND FOOD RETAIL CHAINS BY IN-STORE AND ONLINE NET SALES,[1] 2019 (USD BILLION)

Rank	Company	Headquarters	2019 in-store net sales	2024 estimated in-store net sales	2019 online net sales	2024 estimated online net sales
1	Walmart	US	503	568	49	101
2	Costco	US	151	120	7	168
3	7-Eleven	US/Japan	120	168	–	–
4	Kroger	US	119	135	–	9
5	Lidl Kaufland	Germany	117	145	–	3
6	Aldi	Germany	108	135	–	–
7	Carrefour	France	106	124	–	6
8	Aeon	Japan	82	110	–	–
9	Tesco	UK	82	89	4	6
10	Target	US	71	79	7	18

Source: *Canadian Grocer (2019); dash indicates figure is unavailable.*

In 2015, about 8 percent of American consumers reported ordering a meal or ingredient kit online; this had increased to 18 percent by 2017 (Acosta and Technomic, 2018). In 2019, an estimated 38 million Americans used smartphone apps for OFD services and this trend is projected to increase to 70 percent, or 60 million Americans, by 2023-2024, corresponding to USD 100 billion in revenues (eMarketer, 2019; FMI and Nielsen, 2018). Restaurant OFD options are popular because they offer visible, prepared menu items through mobile apps, a choice of delivery or pick-up, real-time delivery tracking and geolocation notifications for customers (Singh, 2019).

Restaurant and grocery delivery-app services are available to customers in many countries. DoorDash operates in more than 300 cities in Canada and the US; Grubhub partners with more than 30 000 restaurants in more than 1 000 American cities, while Uber Eats operates in more than 1 000 cities worldwide in countries including Brazil, India, Japan and the US. The companies take a percentage of the total price of the food and add a delivery fee to pay drivers (Carson, 2019; Singh, 2019). Postmates operates in more than 90 US cities; Zomato operates in Australia, India and the US; and Deliveroo operates in more than 200 cities across Europe (Singh, 2019). Couriers who deliver groceries or meals to customers in cities rely on tips to top up low rates of pay and are often subject to limited or no work-related benefits and unsafe conditions when making deliveries on scooters, bicycles and motorbikes (de Greef, 2019; Newman, 2019).

Digital transformation of the chain-restaurant sector

Household budget surveys can be a helpful tool for estimating expenditure on food away from home (FAFH), which has increased in many countries. For example, the average Peruvian household has spent over a quarter of its food budget to purchase FAFH since 2010 (Farfán, Genoni and Vakis, 2017). In Brazil, in 2017–2018, FAFH expenditure in urban areas was 33.9 percent of total food spending (IBGE, 2019). In China, demand for chain-restaurant meals increased from USD 10.5 million to USD 94.2 million between 1999 and 2013 (Wang et al., 2016). In the United States, consumer FAFH spending at retailers and chain restaurants combined accounted for an annual average 44 percent of total food expenditure from the 1980s, rising to 50.2 percent in 2010 (Saksena et al., 2018). In the United States, since 2010, FAFH expenditures have outstripped spending on food at home. In 2017, FAFH spending totalled an estimated USD 869.3 billion, while food-at-home expenditure totalled USD 747.0 billion (Elitzak and Okrent, 2018).

1 Revenue is the income a company generates before any expenses are subtracted. Net sales are the proceeds a company generates from selling goods or services to its customers minus returns, sales allowances and discounts.

FAFH expenditures at transnational chain restaurants have also increased over the past four decades. The 2015 Nielsen Global Out-of-Home Dining Survey explored the self-reported eating-out preferences and behaviours of more than 30 000 online respondents in 61 countries (Nielsen, 2016). In a weighted representative sample of online consumers, nearly half (48 percent) reported eating weekly at restaurants or other FAFH locations. Between 14 and 26 percent of respondents in Asia and the Pacific region (Hong Kong, Malaysia, Thailand, Viet Nam and India) said they ate out daily. Some of the reasons cited for eating at restaurants were the reasonably priced food, food quality, service and type of cuisine (Nielsen, 2016).

The top eight global restaurant chains operate in 75-140 countries worldwide, with brand values ranging from USD 7 billion (Burger King) to USD 130 billion (McDonald's) in 2019 (Kraak et al., 2019a; Locke, 2020). IBISWorld (2020) estimates the global fast food industry to be worth USD 860 billion. Most transnational chain restaurants, and the food and beverage manufacturers with which they partner for supplies, supply large portions of energy-dense and nutrient-poor menu items that exceed recommended nutrient targets for energy, fat, added sugars and sodium that undermine healthy diets (Kraak et al., 2019; Kraak, Rincón-Gallardo Patiño and Sacks, 2019). McDonald's Corporation, which leads the quick-service restaurant-chain sector, serves about 68 million customers daily in more than 100 countries. Customers often place and collect their orders at the restaurants' 'drive-thru' windows (Barrett, 2019). In 2019, McDonald's purchased Dynamic Yield, a start-up company that uses algorithmically driven decision technology to predict customer orders. Transnational chain restaurants (such as McDonald's, KFC, Pizza Hut and Domino's Pizza) may provide OFD services directly or partner with third-party companies that earn a commission for delivering meals to customers who order remotely through mobile food-delivery applications (apps) or online (eMarketer, 2019).

In 2019, more than a quarter (26 percent) of 4 500 global consumers surveyed online said they shopped online for restaurant delivery every week (Episerver, 2019). OFD restaurant sales are projected to grow 20 percent globally, from USD 35 billion in 2018 to USD 65 billion, by 2030 (Shoup, 2018; UBS, 2018). Grubhub and Uber Eats are the world's largest food-delivery services (Carson, 2019). In 2019, Uber Eats delivered an estimated USD 10 billion dollars of food worldwide (Carson, 2019). In 2019, DoorDash (27.6 percent), Grubhub (26.7 percent), Uber Eats (25.2 percent) and Postmates (12.1 percent) commanded the highest shares of US consumer spending on OFD services through delivery apps (eMarketer, 2019).

Ethical issues related to the used of digital technology in the food retail sector

With the growth in e-commerce transactions, ethical concerns have been increasingly raised about how current and future digital technologies may infringe on people's privacy and data ownership (Kwet, 2019). Digital technologies may also exacerbate bias and inequities by concentrating power and corporate control of food systems in the hands of a few digital tech and transnational actors (Russo, 2018). Moving to a cashless society has benefits and challenges. It may be convenient for shoppers, but it also exposes personal information to data breaches. It further requires shoppers to have an online bank account or credit card – and, thus, a job – to receive direct salary or wage deposits and to operate effectively in a cashless society (Pritchard, 2020).

Using biometric data to identify or confirm human features or a person's identity may save time and increase security when making online purchases (Hawkins, 2017). However, these systems may not be entirely accurate; hackers can change or steal identities and such systems allow governments to undertake the digital surveillance of populations (Unver, 2018). Citizens may be unaware of the extent to which private corporations track, collect and sell their personal data online when they use personal computers and mobile devices (Kwet, 2019). Algorithmic nudging is used to predict and influence their online choices (Episerver, 2019).

Consumers may also not realize that retailers use bluetooth technology 'beacons' or electronic devices that communicate with the apps on shoppers' mobile phones. These beacons, placed strategically throughout grocery stores, convey information to companies about the amount of time shoppers spend at different products in grocery aisles. Retailers also use 'geofencing' based on global positioning software or radio frequency identification. Geofencing allows companies to send messages to shoppers when smartphones are near or inside stores in a defined geographic area (Kwet, 2019). Geofencing and beacons are location-based digital marketing tools that help companies monitor and understand consumers' online and offline purchasing habits. These technologies require governments to develop comprehensive policies to ensure that consumers' privacy and personal data are protected (Kwet, 2019).

HOW COULD ONLINE FOOD RETAIL SECTOR BETTER SUPPORT HEALTHY AND SUSTAINABLE DIETS?

Food-system stakeholders are using digital technologies in many ways to promote healthy diets and sustainable agrifood systems (GeSI and Deloitte, 2019; Jouanjean, 2019; Renda, 2019; The Food and Land Use Coalition, 2019; Torero, 2020; World Bank, 2019). Food manufacturers and retailers are partnering with farmers who operate "smart farms" that use precision agriculture and technology-enhanced automated devices, linked through integrated systems, to improve the efficient use of soil, water, fertilizers and pesticides. Blockchain technology is being used to enhance food traceability and safe food supply.

In high-income countries, research has shown that online food shopping has the potential to encourage healthy choices, reduce unhealthy impulse purchases by using effective nutrition-labelling strategies and overcome the food constraints faced by people with limited access to stores (Jilcott Pitts et al., 2018). Food manufacturers and retailers are also using AI-enabled devices and the industrial Internet of Things (IoT) to improve efficiency, service operation and supply-chain management (McKinsey & Company, 2019). Cloud technology and the IoT are being used to optimize energy-efficient frozen foods and reduce food loss in the supply chain (GeSI and Deloitte, 2019).

Restaurants are using digital devices to monitor the quality and duration of handwashing by employees (15-30 seconds), using visible-light fluorescence spectroscopy to scan employees' hands for bacteria and viruses, offering virtual assistance from health professionals to provide online support for food-safety and public health questions, and to apply best-practice guidelines to re-open businesses affected by the COVID-19 pandemic (Becker et al., 2020; Fantozzi, 2020; National Restaurant Association, 2020; US FDA, 2020). Government agencies, such as the United States Department of Agriculture (2020), are partnering with Amazon and Walmart to enable low-income customers to use their electronic Supplemental Nutrition Assistance Program (SNAP)[2] benefits to purchase groceries online in a way that will also cover OFD service costs.

2 SNAP provides nutrition benefits to supplement the food budget of needy families so they can purchase healthy food and move towards self-sufficiency: https://www.fns.usda.gov/snap/supplemental-nutrition-assistance-program.

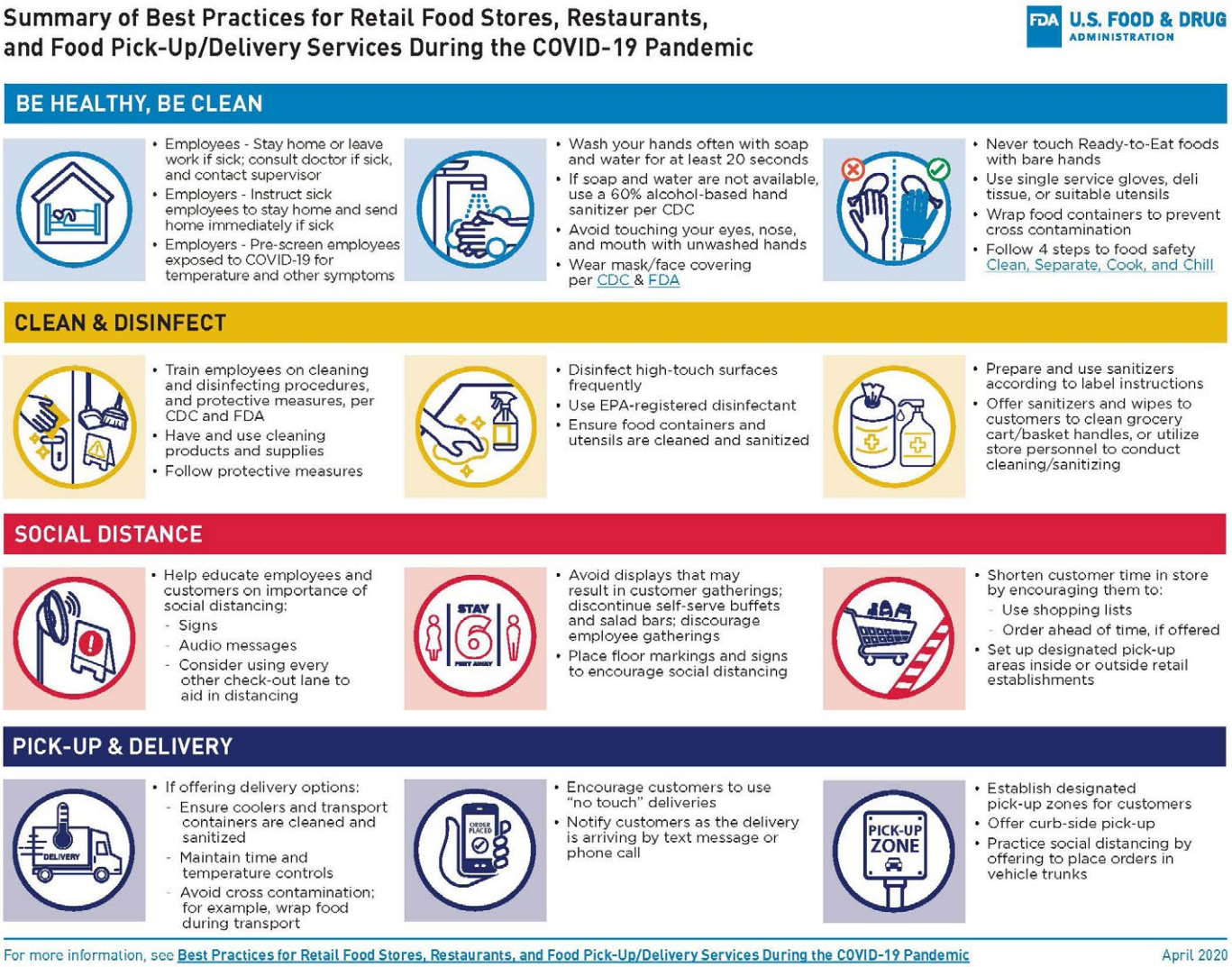
Impact of COVID-19 on the food retail and restaurant sectors

The COVID-19 pandemic is expected to prompt a significant increase in online shopping at major food retail and restaurant businesses due to concerns about crowds in populated cities, government-enforced restaurant closures and limited access to foods in rural and remote locations (Forgrieve, 2020). Market research has described several changes in consumers' food retail behaviour in the first few months of the crisis, including an increase in home food preparation and the use of OFD services (Lahouasnia et al., 2020).

The food retail sector has responded to COVID-19 by limiting human contact between frontline employees and customers, promoting hygiene, encouraging self-checkout counters and using cashless e-commerce (Kuijpers et al., 2020). The crisis has also transformed the restaurant business model within a very short space of time, with thousands of restaurant workers losing their jobs due to forced business closures. Due to the practice of "social distancing" to reduce the spread of the virus, many restaurant chains have changed their practices. Such changes include accepting only drive-through orders and collections or pickups, expanding contact-free delivery services, providing packaged meal-kit deliveries and adopting cashless systems that require e-commerce or smartphone payments. COVID-19 has also affected third-party companies that deliver groceries and meals. Uber (the parent company of Uber Eats), has seen a decline in transportation services, but a rise in its OFD business globally (Isaac and Conger, 2020).

While COVID-19 has shown the potential of digital technologies to protect people's capacity to acquire food, the pandemic has also provided transnational food manufacturers with opportunities to market highly processed, salty and sweet snack products through direct-to-consumer websites that allow e-commerce transactions (Hyslop, 2020). These products do not align with a healthy diet and undermine companies' existing marketing pledges to children and adolescents (Kraak, Rincón-Gallardo Patiño and Sacks, 2019). There is currently limited government regulatory oversight requiring food manufacturers, retailers and restaurants to encourage healthy food products and meals by default to online shoppers. Figure 1 shows best-practice guidelines to assist food retailers, restaurants and OFD businesses in re-opening using established hygiene and food-safety protocols to reduce COVID-19 transmission (Becker et al., 2020; US Food and Drug Administration; National Restaurant Association, 2020). It remains to be seen how the food retail, restaurant and OFD businesses will recover to serve customers profitably in the future.

Figure 1. BEST PRACTICES FOR FOOD RETAILERS, RESTAURANTS AND OFD SERVICES DURING THE COVID-19 PANDEMIC



Source: *US FDA (2020)*

CONCLUSION

Digital technologies influence every sector of the global and national economies, including agriculture, food and beverage manufacturing, food retail and restaurants, finance, media and entertainment. Digital technology is transforming how transnational food retailers and chain restaurants use e-commerce strategies and OFD services to reach customers. Digital technologies are a tool that food-system stakeholders could use more effectively of to address malnutrition in all its forms and to promote healthy diets that align with the 2030 Agenda. To this end, governments must develop strong policies to regulate unhealthy online food-marketing and food retail practices. They must provide leadership to secure adequate resources to promote digital-literacy skills and reduce the digital divide to food-insecure populations. Lastly, governments must develop coherent policy frameworks, ensure the enforcement of regulatory measures and encourage business practices that protect citizens' privacy and data ownership within e-commerce transactions.

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IFAD/MWANZO MILLINGA

Microbiome research, nutrition and social media: A messaging muddle

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The transmission of science through society is necessarily contingent on the dynamics of discourse. The smaller and more similar, or "homophilic", the group (McPherson, Smith-Lovin and Cook, 2001), the more likely it is that rhetoric and genre can be relied upon to deliver effective and accurate information transference (Artemeva, 2016): take, for example, a group of architects analysing a blueprint or expert nutritionists discussing new research at an academic conference. Naturally, the opposite is true: the larger and more diverse the group, the higher the potential for misconception, misunderstanding and misinformation and the easier it is for manipulation and distortion.

Our modern media landscape has become just that, large and diverse. Social-media use is increasing worldwide (We Are Social, 2019), creating incredibly complex and highly effective online ecosystems (Boyd, 2010; Bayer, Triệu and Ellison, 2020; Guilbeault, Becker and Centola, 2018). We know that the impacts on the public are wide-ranging, from beneficial and empowering to damaging and perilous (Bayer, Triệu and Ellison, 2020; Oyeyemi, Gabarron and Wynn, 2014; Briones et al., 2012; Chancellor et al., 2016; Barry et al., 2017; De Choudhury, Morris and White, 2014; Graham, Cobb and Cobb, 2016; Griffiths et al., 2015). When it comes to health science and nutrition, examining the online media portrayal of the microbiome can help shed light on the discursive forces at play, how the public is impacted and what actions might be taken to ensure accuracy and benefits.

In the previous decade, microbiome research was nascent (Ma et al., 2018) and scantly evident in popular media (Cat, 2019). Now microbiome ideas are popping up everywhere. Indeed, it has almost become a household word (Cat, 2019), taking on the language of "gut health" and "gut bacteria" and discussed in relation to "pro- and prebiotics". It is included in lists of beneficial foods and described in therapies that transplant poo.

Extensive research is underway to examine the diverse microorganisms in our environments and the influential roles they play in human health (The Sonnenburg Lab, 2020; Ursell et al., 2012).

This includes examining the microbiome's role in therapeutic responses to cancer (McQuade, 2019), mental health (Valles-Colomer et al., 2019; Taylor, 2019; Pennisi, 2019) and obesity (Stanislawski et al., 2019) and the links that may exist between diet and cardiometabolic and chronic disorders (Aron-Wisnewsky and Clément, 2016). The Health Law Institute at the University of Alberta[1] is currently collaborating on a project led by Stuart Turvey at the University of British Columbia,[2] investigating the microbiome's role in childhood asthma (CHILD Cohort Study, 2018).

While the science is evolving, many questions remain (Ma et al., 2018; Valencia et al., 2017; Walter et al., 2020). There are still only a few microbiome-related interventions ready for use (Katz, 2006; Allegretti, 2019; Johns Hopkins Medical, 2020). This, however, has not stopped a wave of microbiome discourse from circulating online, often with the aim of developing markets for products and therapies. We can see for example, a "3-day gut health makeover" designed to "reboot your microbiome" (Taylor Pittman, 2018), a "14-day gut cleanse" described as "an essential step towards optimal gut health" (Boyce, 2019) and a step-by-step healthy gut plan for "better sleep, clear skin and less stress" that includes a list of probiotics to compliment one's diet (Valenti, 2020).

1 https://www.ualberta.ca/health-law-institute
2 https://bcchr.ca/sturvey

Colonic treatments, for example, such as colonic hydrotherapy (the practice of body flushing), are described as improving gut health (Temple, 2020). So, too, is colonic reflorestation, the introduction of a "healthy intestinal bacteria supplement" (NDNR, 2008). "Raw water" is marketed for introducing beneficial bacteria (Smedley, 2019), as are a range of probiotic supplements – an industry projected to grow to as much as USD 74 billion by 2024 (PR Newswire, 2019), despite a lack of evidence as to their benefits (Reis, Ilardi and Punt, 2018; Kunk, 2019; NHS, 2016).

While clinical research into faecal transplants is promising and ongoing (Kelly and Ananthakrishnan, 2019), there are already cases of highly speculative uses, such as a Canadian naturopath performing faecal transplants to treat children with autism (Lindsey, 2020). The described commercial initiatives, however, should not be seen as isolated occurrences, but rather as often interconnected elements of the highly lucrative wellness industry (Global Wellness Institute, 2018). What's more, the current media landscape acts as a perfect incubator for this wellness industry, often distorting and manipulating the microbiome science (Ma et al., 2018; Taylor, 2019; Caulfield, 2019a).

Celebrities have a massive role to play in the wellness space, where they often spread unscientific, and sometimes dangerous, health misinformation (Caulfield, 2016; Caulfield, 2019b). Stars like Gwyneth Paltrow, Jessica Alba and Elle MacPherson all head wellness companies (Well + Good, n.d.), and searches of their websites reveal an array of products and articles related to gut health. This celebrity discourse promotes health and beauty actions to be taken by the public (Caulfield 2015; 2016; 2019a), but also doubles as a discursive template or strategy to be replicated by self-branding "microcelebrities", commonly known as (social-media) influencers (Khamis, Ang and Welling, 2017).

Unlike many health-related celebrities who have achieved wealth and fame before their forays into wellness, and whose wellness endeavours are an additional means of revenue generation, the online health influencer's influence – and frequently income – centres on the perpetual creation of engaging social-media content (Khamis, Ang and Welling, 2017). These influencers' discourse is almost entirely self-referential and the common narrative is usually one of ongoing self-improvement and personal empowerment (Khamis, Ang and Welling, 2017). Here, the emergence of lifestyle trends like "gut health" can become valuable discursive tools deployed by influencers to create content, and in turn, grow brands, communities and attract further sponsors.

While it might be argued that influencer messaging of this nature is generally constructive, questions persist around the accuracy of the information shared (Caulfield 2019b), as well as the idea that living a healthy lifestyle requires relentless monitoring of products and strategies, a constant scrutinizing of daily life choices (Cederström and Spicer, 2015). If these online influencers are attracting huge audiences, to what degree is simple and effective health information from health-care experts, such as expert nutritionists, drowned out in the noise?

Searches on Instagram for hashtags such as #guthealth (2.2 million results), #probiotics (1.1 million) and #microbiome (250 000) reveal an extensive array of self-described "public figures", "(functional) lifestyle coaches", "brand ambassadors", "dieticians", "bloggers", "recipe creators", "nutritionists" and "gut and mindset experts". There are also explicit "gut health" accounts, such as @theguthealthmd, @theguthealthnutritionist and @guthealthrecipes. In addition to various product accounts (such as @ponoprobiotics), the influencer accounts often feature links to payment-required health and diet plans, social events and personal training, as well as to other social-media platforms, such as YouTube or Twitter. Their content typically portrays motivational messages, celebrated bodies and smiling faces alongside explicit product displays and product promotions. There is talk of changing "gut microbes in as little as one day", "sleep habits for gut health", "anxiety affecting digestion", the "gut-mind connection", the gut as "the second mind" and "gut microbiome needing regular feeding".

Followers of these accounts range from hundreds, to thousands, to hundreds of thousands. Take, for example, Vani Huri, "The Food Babe", who has amassed more than a million followers on Facebook. Her website, www.foodbabe.com, contains an abundance of gut health articles, while her sister site, www.truvani.com, lists an extensive range of probiotic products. Huri, however, has been critiqued for fearmongering and promoting junk nutrition science (Rosenbloom, 2018; d'Entremont, 2015; Godoy, 2014). Further cases include the likes of Belle Gibson, whose lucrative nutrition-based enterprise was constructed around a personal narrative of curing her brain cancer, which did not exist (Khamis, Ang and Welling, 2017; Davey, 2015; Associated Press, 2016). Consumers who seek out a personal microbiome testing kit from biohacker Ben Greenfield (Ben Greenfield Fitness, n.d.a) – sponsored content notwithstanding – might also be influenced by his controversial concerns around vaccine safety (Ben Greenfield Fitness, n.d.b).

For general members of the public, who are going online for health information more than ever before (De Choudhury, Morris and White, 2014; Graham, Cobb and Cobb, 2016; Griffiths et al., 2015; European Parliament, 2017), misinformation and disinformation remain a pressing concern (European Parliament, 2017; Edelman, 2019; Mitchell et al., 2019; BBC News, 2018). Research has shown that misinformation, including blatantly "fake news", has a greater ability to go viral than the truth (Vosoughi, Roy and Aral, 2018), is a powerful tool in creating hesitancy and doubt (Pennycook, Cannon and Rand, 2018) and is sometimes encouraged by automated accounts, commonly called "bots" (Allem, Escobedo and Dharmapuri, 2020; Shao et al., 2018; Reinhart, 2020; Pedersen, Szeto and Tomlinson, 2020; DiResta and Lotan, 2015). As concerted tactical strategies are deployed to muddle the media (Illing, 2020; Kakutani, 2019) and with trivial health information often drowning out the core important messaging (Vassey et al., 2019; Ioannidis, 2019), it is often the case that searching for truth can be an exhausting endeavour (DiResta and Lotan, 2015; Illing, 2020; Kakutani, 2019).

As the public struggles to decipher what's accurate, it is important to remember that creating discourse can never be neutral – not for news companies and journalists influenced by the algorithms governing clicks and attention (Diakopoulos and Koliska, 2017; Christin, 2014; Gettler, 2019), not for influencers striving to increase social capital and the potential for revenue (Khamis, Ang and Welling, 2017), not for academics promoting their research (Caulfield and Condit, 2012). Each act of discourse is an act of aligning and positioning (Hajer, 1993), where subjects assume roles and achieve greater value in hierarchical communities (Angermuller, 2018). Pertinent are the critiques, therefore, that question how and why some certain information gains prominence, and who it is that profits from the attention it garners (Levinovitz, 2020; Caulfield, 2015; Cederström and Spicer, 2015).

Here, the role of (social-) media companies cannot be understated. Their central objective is to maintain a platform that increases use (Karppi, 2018). And driving use is enormous business. Platform algorithms, therefore, with only some exceptions, continue to promote whatever it is – and whoever it is – that generates attention (Karppi, 2018). As observed, the reciprocally beneficial mixture of influencers and brands typically flourishes while complex truths struggle for traction.

We can all benefit greatly from being more critical of the news we encounter and the platforms we use (Pennycook et al., 2019). Media companies are only likely to modify their platforms if they are pressured to do so (Mole, 2019; Stewart, 2019). So, when it comes to the hyping and distorting of microbiome research (Ma et al., 2018; Taylor, 2019; Global Wellness Institute, 2018; Hanage, 2014; Slashinski et al., 2012), health-care practitioners and public health officials need to know the range of perspectives held by the public, how these viewpoints have formed and which communicative tools and strategies can be effectively deployed (Milne, Caulfield and Tepper, 2017). By developing and deploying creative, evidence-informed communications strategies (Caulfield et al., 2019; Crowe, 2019; Skype a Scientist, 2020; Science. Sam, 2017; Hatch, 2018), we can collectively encourage the transmission of accurate information, help limit the polarization of discussions (Attwell, Smith and Ward, 2018; Blendon, Benson and Casey, 2016; Sunstein, 2018, Mole, 2019) and hopefully instil greater trust in our systems.

Research shows that some divisions among the public are indicative of diverse interpretations of science (O'Brien and Noy, 2015). However, research also shows that scientific knowledge and understanding play a larger role in constructing scientific beliefs than, say, political ideology (McPhetres and Pennycook, 2019). Consequently, all scientists, public health officials and educators must ask earnestly and ardently how their actions – including their discourse – are contributing to a more informed, more intelligent and more discerning public.

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Digital solutions to promote nutritious foods: Value chains for biofortified staples

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Micronutrient (mineral and vitamin) deficiency is one of the three forms of malnutrition, alongside overweight or obesity and undernutrition. It affects more than 2 billion people globally, causing health problems, reducing productivity and curtailing income at individual and national level (IFPRI, 2016). Malnutrition, in all its forms, can be tackled with a healthy diet. Current food systems are unable to provide healthy diets for many, however, especially those in rural areas who cannot access or afford nutrient-dense foods and rely on staple crops for their calorific needs. The biofortification of staples commonly grown and consumed in lower- and middle-income countries (LMICs) with key micronutrients (such as vitamin A, iron and zinc) is a cost-effective and scalable strategy with proven potential to improve the micronutrient access of the population (Lockyer, White and Butriss, 2018; HarvestPlus, 2019; Bouis and Saltzman, 2017).

Digital technologies have proven potential to empower poor populations with new communication tools, to facilitate connectivity along the value chain and to equip farmers with knowledge on key challenges (such as weather) and opportunities (such as the traceability of foods).

To identify any bottlenecks in the supply of biofortified seed to food supply chains and to benefit from the digital revolution in agriculture, HarvestPlus, the global leader in biofortification, consulted with key food-system stakeholders, including seed companies, farmer organizations, farmgate vendors, food processors, marketers of all sizes and multinational, global food brands. These discussions revealed that while there is high demand for biofortified foods, there are also bottlenecks to scaling them up, many of which could be eased by technological solutions (Walton, 2019).

Table 1. SUMMARY OF BOTTLENECKS TO UPSCALING AND THE DIGITAL SOLUTIONS FOR TACKLING THEM

Bottlenecks to scale	Digital solutions
• Demand for biofortified seeds, crops and foods exist, but supply does not meet demand	• Linking all supply-chain actors with digital marketplaces and e-commerce • Facilitating the estimation of seed and food so that seed producers and farmers can plan their supply to meet the demand
• Lack of reliable, timely and targeted messaging and information on the benefits of biofortified seeds, crops and foods for value-chain actors	• Using radio, phone messaging and social media in awareness-raising campaigns
• Lack of standards at grain level • Inability to rapidly test grain for nutrient content	• Virtual meeting places and electronic working groups for global experts to create globally acceptable, commercially driven standards • Standards that are easily available in digital formats and mobile ready • Easy-to-use and cost-effective digital tools for assessing the micronutrient content of products
• Preservation of identity throughout the supply chain	• Implementing traceability schemes with technology such as distributed ledger technology (DLT) or blockchain

Source: *Adapted from Walton (2019)*

Here, we outline the potential of such digital solutions along biofortification supply chains.

DIGITAL MARKETPLACES

Digital technology-based solutions can enable supply-chain participants to share information (such as inventory data and demand forecasts), communicate and collaborate more effectively and design more efficient supply-chain structures. One example of the application of such solutions to biofortification is the BioFort Stat marketing portal in Nigeria (HarvestPlus, n.d.). The portal collates data on biofortification activities, such as households reached with biofortified planting material, quantity harvested and market prices, to help link crop producers to other actors in the biofortification value chain. Another example can be found in Uganda, where HarvestPlus has been linking producers of biofortified crops to input providers by leveraging technologies such as a sweet-potato mobile application (app) (Atero, 2019). Farmers use this app to locate certified planting material and get agronomic information on biofortified crops.

CONNECTING WITH HARD-TO-REACH FARMERS BY MOBILE PHONE

While sub-Saharan Africa's uptake of smartphones has been fairly slow, mobile-phone use has been increasing rapidly. According to the African Green Revolution Forum's 2019 report, 44 percent of sub-Saharan Africans own a mobile phone (AGRF, 2019). It is projected that more than half them will have a mobile-phone connection by 2025 (GSMA, 2019).

Mobile phones unlock great potential to increase productivity and enhance the income levels of smallholder farmers by providing timely input and output market information, agronomic advice and access to financial services.

HarvestPlus has partnered with Precision Agriculture for Development[1] to reach smallholder farmers who are not easily reached by face-to-face extension services. To test the cost-effectiveness and impact of digital technology in the biofortification context, a two-way information system will be implemented through mobile phones to provide information to smallholders in Pakistan in 2020. The information will include the effects of zinc deficiency and the benefits of increased zinc intake for family health, where to purchase zinc wheat seed and demand from millers for zinc wheat to turn into biofortified flour.

IMPLEMENTING BLOCKCHAIN FOR SUPPLY-CHAIN INTEGRITY

Blockchain, or distributed ledger technology (DLT),[2] may be an effective tool for ensuring the traceability of agricultural products, providing peace of mind for consumers and increasing value for farmers, while enhancing productivity and incomes. HarvestPlus has been working with The New Fork to apply DLT to a key issue: the ability to track and authenticate the origin of biofortified seed and food through value chains. HarvestPlus and the New Fork are currently assessing the feasibility of blockchain in Nigeria's vitamin A maize biofortified seed value chains. Current investigations are focused on mobile-phone ownership and users, mobile network coverage, willingness to take part in the project and training. The results will be available in 2021.

According to de Ruyter de Wildt et al. (2019), such digital solutions are only useful if users have consistent access to a digital network. Mobile-phone ownership in the agricultural community is increasing at a brisk pace, not onl
y among young entrepreneurs who are driving innovation and growth in the agrifood sector, but also among farming households.

Mobile-based blockchain solutions are expected to take hold in LMICs. Inclusive implementation of participatory approaches at the community level will be needed to reduce the potential for information inequality (for example, targeted policies that ensure women are not omitted from agricultural digitalization, particularly in rural areas). Inversely, digital technologies also have the potential to tackle the inequity in information access often faced by the poor.

1 https://precisionag.org/

2 Blockchain, or distributed ledger technology (DLT), is an innovation in monitoring and documenting supply-chain transactions. Each transaction (such as seed sold to a farmer) is uploaded to a digital ledger. Each ledger can be accessed by users in the value chain at any time, to quickly understand exactly where a product has come from and where it has gone next. As this is digital, it requires little user interface and no paper or intensive bookkeeping; the data cannot be changed, so offers security (https://thenewfork.com/).

CONCLUSIONS AND INSIGHTS

Amid disruptions to transport and the social-distancing measures put in place in an effort to contain the COVID-19 pandemic, digital solutions have proven once again how relevant and timely they are. Like many other organizations, HarvestPlus has modified its operations in many countries, moving farmer meetings and training sessions to digital platforms. HarvestPlus country teams report the successful use of social platforms, such as WhatsApp, to reach farmers efficiently and cost-effectively, though rigorous research is needed to validate the efficacy of such practices at scale.

HarvestPlus's experience of scaling up biofortification has enabled it to identify certain insights into tackling some of the value-chain bottlenecks that must be overcome if we are to scale up food-system solutions:

- Consult with digital technology experts to find the most appropriate (easy-to-use, scalable and cost-effective) digital solutions to alleviate these bottlenecks.
  - Cast a wide net to find the best service provider to deliver the digital technology solution— the biggest provider may not be the most suitable for your programme needs— try leveraging existing systems and platforms (digital or otherwise).
- Take risks! Innovation, by definition, is unproven. Be thorough in your risk assessment, but also be prepared for failures and to learn quickly from them.
- Assess the solutions you are implementing with an inclusivity/equity lens, then document and share your learnings, as we all need to work together to transform food systems to deliver better-quality diets for all.

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Digital technologies to improve Zimbabwe's food and nutrition security information system

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INTRODUCTION

Policymakers and development partners are increasingly recognizing food and nutrition security as a key element in achieving the Sustainable Development Goals (SDGs) (Tinarwo and Uwizeyimana, 2019). Still, efforts to eradicate hunger and malnutrition hinge on the availability of reliable data, statistics and information, the capacity to analyse this information and the communications skills to inform decision makers (FAO, 2019). The protracted nature and magnitude of hunger and malnutrition in most developing countries underscores the need for a reliable and sustainable food and nutrition security information system (FNSIS) to address the determinants and dynamic nature of food and nutrition insecurity at the national, regional and global level (UNECA, 2011; Suresh and Ergeneman, 2005).

Food and nutrition security information generally comes from myriad sources, including government departments, donors, academia, research organizations, the private sector and non-governmental organizations (NGOs). This fragmentation often hinders a cohesive understanding of the determinants and outcomes of food and nutrition security. Determined action is needed to coordinate and harmonize these sources of data (Lenneiye, 2000).

The World Bank (2019) defines digital technologies as tools that collect, store, analyse and share information digitally, including mobile phones and the internet. Digital technologies in food and nutrition security are crucial to ensuring evidence-based programming and to improving public services (Trendov, Varas and Zeng, 2019). Harnessing digital technologies can significantly reduce the costs of linking food and nutrition security information to producers and consumers within the food system. Such technologies can help bring together data from various sources, overcoming fragmentation and maintaining up-to-date information and knowledge to better target the poor and vulnerable when designing food and nutrition security interventions.

THE CASE OF ZIMBABWE

Zimbabwe's national Food and Nutrition Security Policy includes a government commitment (Commitment IV) to maintaining an integrated FNSIS that provides timely and reliable information on the food and nutrition security situation and the effectiveness of programmes to inform decision-making (FNC, 2012). It says the FNSIS is designed to identify the breadth and scope of food and nutrition insecurity, to assist in the prioritization and planning of food and nutrition security interventions (FNC, 2012). The FNSIS strives to provide prompt evidence for emergency response, recognizing the effectiveness of a multisectoral approach, and to track its progress and impact (FNC, 2014).

The Zimbabwean FNSIS is designed to provide different stakeholders, including the government, donor agencies and NGOs, with food and nutrition security information to ensure evidence-based programming. It comprises various defined assessments and monitoring instruments that together provide a comprehensive understanding of the food and nutrition security situation, as shown in Table 1.

While conceptually sound, Zimbabwe's FNSIS is still being developed. Data quality is unreliable and the system lacks sustainability. This study aims to explore the potential of digital technologies to help set up a more reliable and sustainable FNSIS in Zimbabwe.

Table 1. SOURCES OF FOOD AND NUTRITION SECURITY INFORMATION IN ZIMBABWE

Source	Description	Responsible agencies
Zimbabwe Demographic and Health Survey	Collects and disseminates national data on several health and population indicators, including nutrition	Government of Zimbabwe, United States Agency for International Development, United Nations Children's Fund (UNICEF), United Nations Population Fund, Joint United Nations Programme on HIV/AIDS and World Health Organization
National Nutrition Surveillance System	Collects nutritional information annually during the peak hunger season (just before harvest)	Government of Zimbabwe, Food and Agriculture Organization of the United Nations (FAO), UNICEF and World Food Programme (WFP)
Zimbabwe Vulnerability Assessment Committee	Collects and analyses comprehensive data on the determinants of wasting, including information on dietary intake, food security, illness (recent diarrhoea, fever or cough in children under the age of five) and water and sanitation	Government, United Nations, NGOs
Agriculture and Food Security Monitoring System	Collects data in 57 out of 60 districts once a quarter; also conducts a household food consumption survey every year in October, at the start of the hungry season	Government
Crop and Livestock Assessment	Carried out twice a year with analysis of data disaggregated to ward level	Government, with support from development partners
Health Information System (HIS)	Collects monthly reports on most diseases and health conditions, including wasting, underweight and pellagra (due to niacin or vitamin B3 deficiency disease); has a weekly disease surveillance system that monitors outbreaks of diseases of public-health importance, such as cholera, malaria and measles	Government, with support from development partners
Annual mapping exercises	Conducted by the Nutrition Technical Coordination Group to produce a Nutrition Atlas on the activities of government and NGOs; the Agricultural Working Group undertakes a similar annual mapping exercise for the food security sector	Government, with support from development partners

Source: *Author's compilation based on SUN (2014)*

METHODS

The research involved a mixed-methods survey of explanatory sequential design (Creswell, 2014), conducted in November and December 2019. A short questionnaire initially disseminated to 62 selected representatives of government, development partners, academia, research organizations and the private sector (Table 2), to capture their views on the pros and cons of applying digital technologies to the FNSIS.

Based on the initial survey responses and to dig deeper into respondents' views on how to build a robust FNSIS more generally, as well as the potential of digital technologies to make this happen, the author conducted semi-structured key informant interviews with 12 of the 62 interviewees, representing the different stakeholder groups (Table 3).

Descriptive statistics were used to analyse quantitative data generated by the questionnaire, while thematic analysis was used to analyse the qualitative data from the semi-structured interviews.

Table 2. DISTRIBUTION OF 62 RESPONDENTS BY STAKEHOLDER GROUP AND GENDER

Stakeholder	Total	Male	Female
Government	22	14	8
Development partners	12	7	5
Academia	17	11	6
Research organizations	7	5	2
Private sector	4	3	1
Total	**62**	**40**	**22**

Source: *Author survey*

Table 3. DISTRIBUTION OF 12 KEY INFORMANTS BY STAKEHOLDER GROUP

Stakeholder	Total
Government	3
Development partners	2
Academia	4
Research organizations	1
Private sector	2
Total	**62**

Source: *Author interviews*

RESULTS

1. The survey

Table 4 shows survey responses on the advantages of digital technologies for building a reliable and sustainable FNSIS. It shows that 78.0 percent of respondents strongly agreed that digital technologies cut the costs of data-collection considerably, while 80.2 percent strongly agreed that they reduced inequality of access to information among stakeholders in the food and nutrition security. Moreover, 78.6 percent of respondents strongly agreed that digital technologies helped government and stakeholders to process and analyse FNSIS data more quickly.

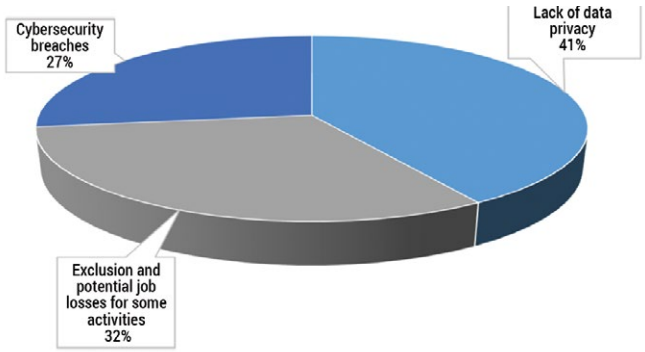
Table 4. POTENTIAL OF DIGITAL TECHNOLOGIES TO BUILD A RELIABLE AND SUSTAINABLE FNSIS (N=62)

Potential of digital technologies	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Considerably reduce the cost of data-collection	78.0%	15.0%	3.0%	4%	0%
Decrease inequalities in access to information among stakeholders	80.2%	18.6%	1.2%	0%	0%
Help government and stakeholders to process and analyse data faster	78.6%	18.5%	2.9%	0%	0%

Source: *Field survey responses, 2019*

Figure 1 shows the survey responses on the potential risks of digital technologies: 27 percent of respondents believed that digital technologies could result in cybersecurity breaches, while 32 percent believed the use of digital technologies in FNSIS might result in exclusion and job losses for certain activities. Lastly, 41 percent said they thought that the use of digital technologies in FNSIS could result in a lack of data privacy.

Figure 1. POTENTIAL TECHNOLOGICAL RISKS TO BUILDING A RELIABLE AND SUSTAINABLE FNSIS (N=62)



Source: *Field survey responses, 2019*

2. Semi-structured interviews

The 12 semi-structured interviews indicated that stakeholders believed the use of digital technologies could help to establish a reliable FNSIS in Zimbabwe, a crucial tool for ensuring evidence-based policymaking and implementation in the food and nutrition security sector.

While efforts to build an FNSIS in Zimbabwe were lauded, a number of interviewees cited a lack of coordination and harmonization between the various sources of information. Data are currently provided by numerous organizations, often resulting in duplication and a lack of standardization, fuelling concerns about data accuracy and reliability. Furthermore, the interviews suggested that the current FNSIS institutional framework involved a complex web of relationships within and between government, development partners, research organizations and NGOs, resulting in the duplication of roles and activities as well. Food and nutrition security issues fall under the purview, to one extent or another, of 17 different ministries, numerous development partners and various NGOs, creating a weak intersectoral mechanism and fragmentation, especially at national level. For example, food security and, more specifically, food production are coordinated by the Ministry

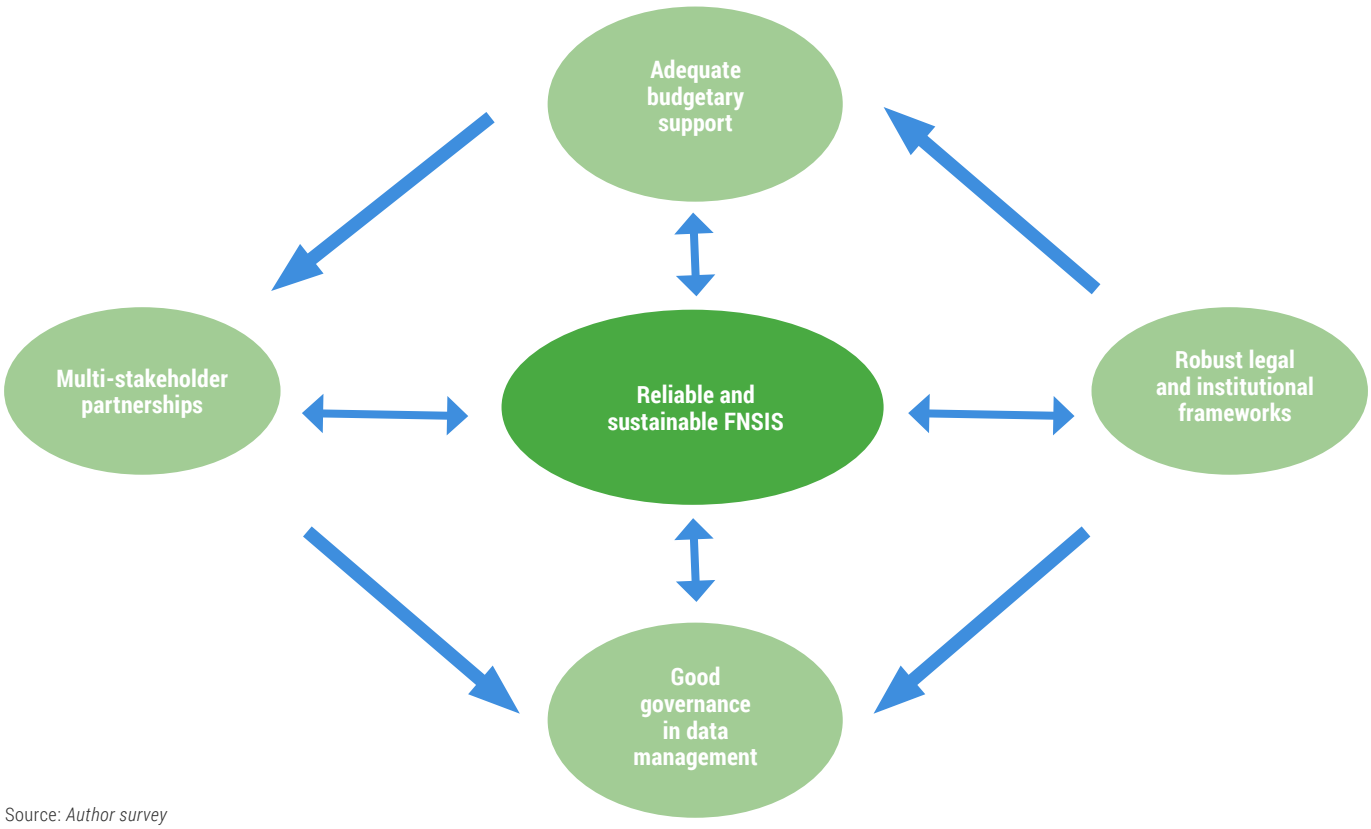
of Agriculture, while nutrition issues are coordinated by the Ministry of Health. Social assistance is the responsibility of the Ministry of Labour and Social Welfare. The Food and Nutrition Council (FNC), meanwhile, tasked with multisectoral coordination, lacks the resources to carry out its responsibilities.

The interviews highlighted the importance of joint working groups to help converge the disparate views of partners on policy, strategy and priorities. For example, the Zimbabwe Vulnerability Assessment Committee is a platform comprising government, donor agencies, civil-society and research organizations. It conducts regular national assessments of vulnerability, food security, nutritional status and health. Lastly, the interviews indicated that despite the fact that digital technologies can help overcome these barriers, a lack of adequate budgetary support is one of the most serious challenges to the proper use of digital technologies to build a reliable and sustainable FNSIS in Zimbabwe. Current efforts to establish a FNSIS are largely dependent on donor funding, sometimes project based, with limited government financial support, inconsistent with long-term sustainability.

3. Conceptual framework for a reliable and sustainable FNSIS

These quantitative and qualitative insights enabled the creation of a conceptual framework for building a reliable and sustainable FNSIS, as presented in Figure 2. Adequate budgetary support is crucial. Countries that have successfully built a FNSIS have allocated sufficient financial resources and not just relied on donor support (for example, Bangladesh and Somalia) (FAO, 2015). It is also imperative that robust legal and institutional frameworks are in place. Furthermore, there needs to be both human and institutional capacity-building to manage the FNSIS and, crucially, multi-stakeholder partnerships. The roles of government, donors, civil society, research organizations and the private sector need to be harnessed and aligned, especially to mobilize the required resources (Tinarwo, Babu and Iyappan, 2018). Lastly, good governance of data management is critical to ensure that data are consistent and trustworthy (World Bank, 2019). In most developing countries, the rules on data ownership and use are often inadequate, raising concerns about data misuse (World Bank, 2019).

Figure 2. PROPOSED CONCEPTUAL FRAMEWORK FOR A RELIABLE AND SUSTAINABLE FNSIS



Source: *Author survey*

DISCUSSION

To build a culture of evidence-based policymaking, it is imperative that the Government of Zimbabwe invest to strengthen all elements of its FNSIS in an integrated way. Digital technologies are seen as tools with the potential to coordinate and harmonize the different information systems of various stakeholders, so as to build and nurture this integration.

A concerted effort is needed to bolster partnerships between stakeholders that generate food and nutrition information at both the local and national level. Data and technology sharing between government and other stakeholders needs to be strengthened. For example, Zimbabwe's partnerships with global organizations, such as the Famine Early Warning Systems Network, WFP and FAO, are laudable, but roles and responsibilities need to be clarified to avoid duplication. The participation of civil-society organizations in generating data at local level needs to be harnessed, as these groups have the comparative advantage of working with communities. The participation of the private sector, research organizations and farmer-based organizations in the FNSIS remains ad hoc and minimal. Including these stakeholders in a structured way would entail giving them responsibility for information generation and making them accountable for these tasks. An expansion of the FNSIS to include more stakeholders, representing a broader array of stakeholders, would increase the variety of the food and nutrition security information generated, making it more transparent and inclusive.

The Zimbabwean FNSIS organizational structure would greatly benefit from taking a multisectoral approach that included all stakeholders: the government, development partners, civil society, research organisations, academia, the private sector and farmer-based groups. The FNC, a technical arm in the Office of the President and Cabinet, could host the FNSIS, as it has the overall mandate for a cohesive national response through multisectoral coordination, including research, capacity-building, and monitoring and evaluation (FNC, 2012).

FAO, as the specialized United Nations agency responsible for collecting, analysing, interpreting and disseminating information and knowledge related to food security, is a key partner in providing the financial and technical support needed to establish the Zimbabwean FNSIS. However, its project-based approach to development assistant is not enough to enhance evidence-based analysis for informed policy design, monitoring and evaluation (FAO, 2015). Secure, reliable and budgeted national funding is essential.

A lack of adequate budgetary support is one of the major challenges faced by governments adopting digital technologies to build a reliable and sustainable FNSIS. Most developing countries that established an FNSIS relied on donor support to do so, which is not sustainable. Here, it is imperative that governments strengthen domestic resource mobilization to ensure adequate financial resources, including operating costs. Where possible, governments should foster public–private partnerships to increase resource mobilization.

Lastly, human and institutional capacity-building is required to build a reliable and sustainable FNSIS. Indeed, training programmes to enhance digital literacy are essential to ensuring adequate skills and technical capacity in information management at both the local and national level. For example, Zimbabwe's FNC, which is responsible for hosting and integrating the country's FNSIS, needs to be given the capacity and adequate resources to satisfactorily discharge its mandate.

CONCLUSION

Harnessing digital technologies could enhance the construction of a reliable and sustainable FNSIS in Zimbabwe, ensuring evidence-based programming and improving public services. However, the use of digital technologies is not a magic bullet. Data quality needs to be prioritized. Also, digital technologies pose several challenges that need to be addressed effectively, including exclusion, a lack of data privacy and cybersecurity breaches. Other challenges impeding the use of digital technologies in Zimbabwe and elsewhere include poor network coverage, power/electricity load shedding and a lack of digital infrastructure. Mitigating these risks calls for measures that lower barriers to service-provider entry, ensure good data governance and foster inclusion through targeted support. Adequate budgetary support to complement donor support is one of the most essential elements in building a reliable and sustainable FNSIS in Zimbabwe.

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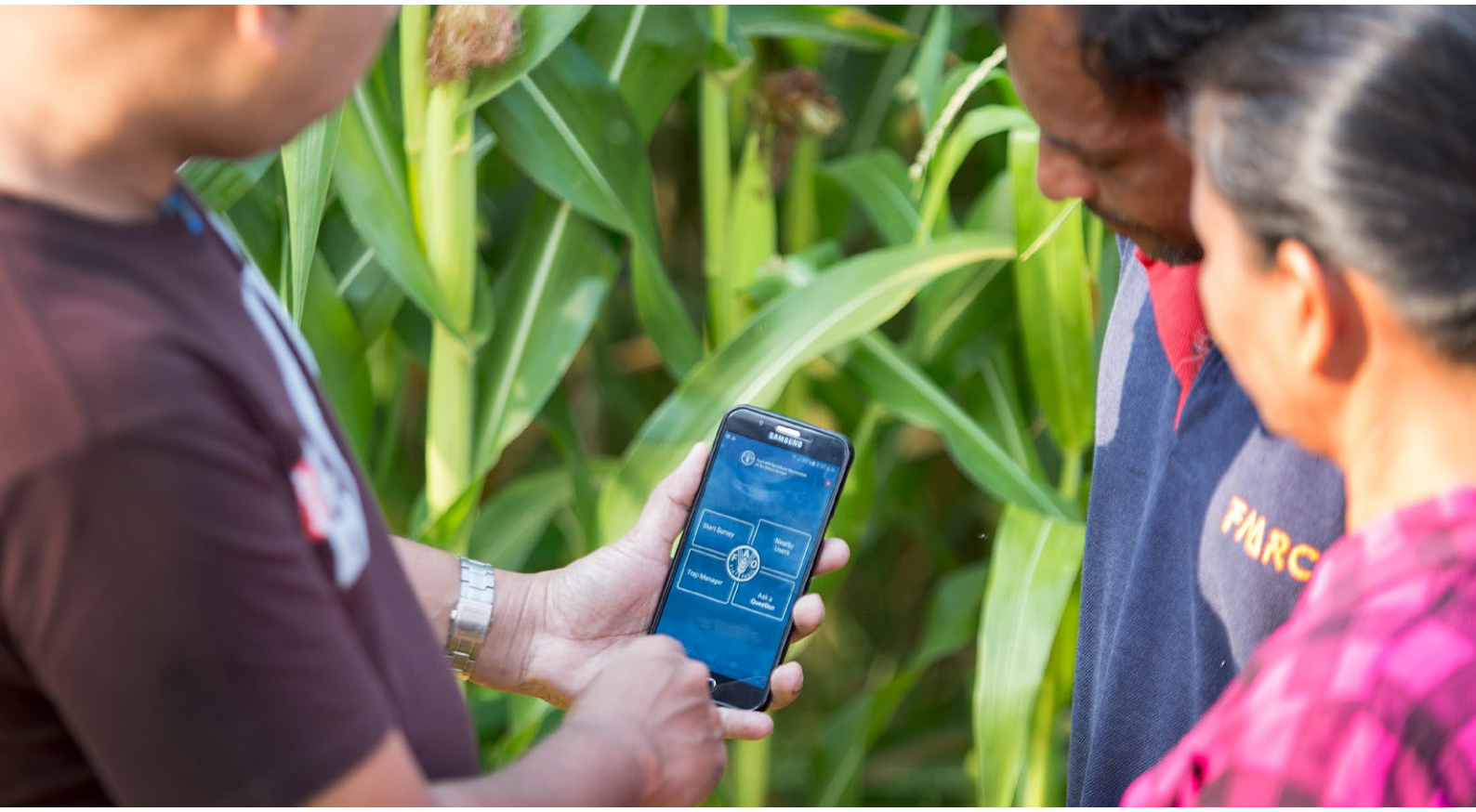

FAO/LEKHA EDIRISINGHE

Digital technology to boost agricultural output, improve the food environment and reduce malnutrition in Africa

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INTRODUCTION

In 2015, the United Nations officially adopted the Sustainable Development Goals (SDGs), with the ambitious target of ending global hunger by 2030 (Samberg, 2018). Since then, however, estimates from the Food and Agricultural Organization of the United Nations (FAO) show that the number of people without enough food has actually increased, from 785.4 million globally in 2015 to 821.6 million in 2019 (FAO, 2019a). Rising demand for food, driven by population growth and urbanization, has sparked the need for a constant supply of safe, diverse and nutritious foods in rural and urban areas. A poorly structured food environment, compounded by insufficient agricultural output, has led to food insecurity and a rise in the number of malnourished people.

In Africa, the food insecurity situation is worst, with 277 million people estimated to be severely food insecure in 2019. The prevalence of undernutrition has seen a steady increase since 2015, as have the number of overweight people in the same populations (FAO, 2019a). Over the years, various strategies have been adopted in a bid to find a solution and reduce the triple burden of malnutrition, including nutrition-specific and nutrition-sensitive interventions (UNICEF, 2015), but progress has been slow. Structural adjustment polices managed to halve the number of undernourished people globally just prior to and during the Millennium Development Goal era (2000–2015). The 17 SDGs and their targets are the goals for 2030. The 2019 SDG Progress report showed some countries on track to meet their targets, while numerous others were not (UNDESA, 2019). To achieve the SDGs, improving the performance of the food system is central.

Ensuring a healthy diet for an expected global population of close to 10 billion by 2050, while at the same time improving the world these people live in, requires sweeping changes to farming and how we produce food (Leahy, 2019). Technological innovations, such as digital technology, are frequently mentioned and discussed in policies, strategies and reports by governments and multilateral organizations. The World Bank, for example, identifies the need to expand digital opportunities to everyone, including farmers and agribusiness, as a way of improving food systems and achieving the SDGs (World Bank, 2019). The role of digital technology in improving the food environment and reducing malnutrition still needs critical analysis and quantification, however, particularly in the case of Africa.

More than half of people living in Africa depend on agriculture for all or part of their livelihood; in some parts of Africa, the number is as high as 70 percent (Biteye, 2016). Growing recognition of poverty as the root cause of hunger and malnutrition means agricultural development has a pivotal role to play in improving nutrition by increasing the quantity, quality and variety of foods available and by creating employment and income-earning opportunities for the poor. Hence, ending poverty and hunger by 2030 can only be achieved by making the food system more robust, sustainable and resilient, transforming it from a major contributor to climate change into part of the solution. This will require more climate-smart agriculture, aligned with better nutritional outcomes, stronger food value chains and improved market access (World Bank, 2015).

Breakthroughs in digital technology have the potential to deliver significant positive impacts across food value chains in Africa, through the application of innovations that can make food systems more resourceful, climate-smart and resilient (World Bank, 2019). The use of digital technology can help reduce costs, enable farmers to make more accurate decisions and improve access to information, knowledge and markets. This paper describes the potential role of digital technology in improving food environments, boosting agricultural production and ultimately reducing malnutrition in Africa. It outlines the evolution of digital technology for food security and agriculture in Africa, providing a few examples of technology currently in use, before exploring the potential for improving food environments for better nutritional outcomes.

EVOLUTION OF DIGITAL TECHNOLOGY FOR FOOD SECURITY AND AGRICULTURE IN AFRICA

As the Green Revolution of the 1950 and late 1960s was revolutionizing agriculture and benefiting the world, Africa was largely excluded from the process due to the overwhelming levels of poverty across much of the continent, especially the sub-Saharan regions (Dimond, 2015). The Green Revolution did little for the poor, vulnerable farmers who lacked access to inputs such as fertilizers, hybrid seeds and water (Infonet, 2020). The "new revolution" in agriculture is a digital one and it is essential that Africa be part of it.

New solutions to fostering food and nutrition security include information and communications technology (ICT) for the agricultural sector. ICT, which includes communication devices and applications (apps) for mobile phones, computers, broadband network hardware and software, and satellite systems, is gradually becoming more widespread in Africa. Information and communication are nothing new, however. Ever since people have grown crops, raised livestock and caught fish, they have sought information from one another on effective planting strategies, better seeds and market prices, among other things (World Bank, 2017). Farmers relied on traditional ways of predicting weather changes. They would know when to prepare land for tilling or be able to predict pest infestation (and so increase production to reduce post-harvest loses). Indigenous knowledge of food systems, such as conservation agriculture, included crop rotation to reduce water evaporation, control pests and reduce the use of herbicides. However, this traditional weather forecasting and indigenous knowledge of food systems is slowly being lost as the knowledge transfer from the older generation to the young tapers off. With improving economies and booming trade across Africa, radio and television have taken over as the main sources of information for farmers, as rural information services have traditionally focused on providing content for these media.

More recently, mobile technology has been coming to the fore, influencing most sectors of the economy in Africa, particularly health and education, with mobile coverage and penetration in most rural environments. In 2017, the number of mobile-phone connections on the continent was around 747 million, equivalent to a 75 percent penetration rate (Kah, n.d.).[1] In some African countries, the penetration rate is 100 percent (Ponelis and Holmner, 2015). Evolving mobile technology has given rise to several start-ups across Africa aimed at developing ICTs to improve income through agribusiness and, thus, ensure food availability and accessibility.

Digital solutions for food security and agriculture: Examples from Africa

Digital technology is transforming Africa's food system in numerous ways. In 2018, there were about 390 registered digital solutions on the continent, a phenomenal rise from just 41 in 2012 (Tsan et al., 2019). Digital innovations and technologies may be part of the solution to bringing about urgent transformation of the agrifood system (Trendov, Varas and Zeng, 2019).

Examples of how digital solutions are changing the way Africa farms include the use of innovative digital and mobile technologies to prevent, detect and respond to infectious diseases in animals, humans and plants.

A study by Karimuribo et al. (2019) describes the development and initial achievements of a participatory disease surveillance system called techno-health, an ICT-based solution to enhance early detection, timely reporting and prompt response to health events in human and animal populations in Africa (FAO, 2019b). Digital tools were developed and packaged as the AfyaData app to support One

1 The mobile penetration rate measures the number of SIM cards in a population.

Health disease surveillance, giving people an opportunity to engage in the detection of infectious diseases in their own communities (FAO, 2019b). By promptly discovering and responding to infectious disease, farmers can save their animals from potential threat and prevent its spread to humans.

Another example is how technology is being used to disseminate key information to farmers in a timely manner. An estimated 33 million people, or about 13 percent of all sub-Saharan African smallholders and pastoralists, are already registered with a mobile phone-based service for weather updates, market connections, etc. (Karimuribo et al., 2019). In Ethiopia, the free 80–28 hotline is a farmer advisory service with 4 million subscribers. Its use of local languages has been instrumental in aligning services to local circumstances (Karimuribo et al., 2019). In Ghana, Farmerline and AgroCenta use mobile and web technologies to disseminate farming advice, weather forecasts, market information and financial tips to farmers who are traditionally out of reach due to connectivity, literacy or language (Ekekwe, 2017).

The Kenya Agricultural Observatory Platform, meanwhile, was developed by the Kenya Agricultural & Livestock Research Organization to give farmers valuable insights in the form of weather analysis, agronomics and analytics. It provides accurate real-time and historical records of relevant weather variables, including short-term weather forecasts by county. Thus, farmers can plan when to start planting and avoid losses. Another Kenyan innovation aimed at improving productivity through precision insights is Ujuzikilimo, which uses big data to bring farmers together in a knowledge-based community (Ekekwe, 2017).

One cost-effective, easy-to-use, climate-smart ICT service is GeoFarmer, based on infrastructure and services currently available to small-scale producers in developing countries. GeoFarmer provides near real-time, two-way data flows that can be used to monitor agricultural production systems, with interactive feedback between users. This novel technology has been tested in Ghana, Tanzania and Uganda and has shown to be a cost-effective means of sharing beneficial indicators of on-farm performance (Eitzinger and James, 2019).

The digitalization of agriculture has attracted young people to farming by offering employment and opportunities for business (FAO, 2018).

Digital technology can help to close the gender gap in agriculture, too, by improving women's access to financial services and agricultural inputs. Tsan et al. (2019) note that in sub-Saharan Africa, where 40–50 percent of smallholder farmers are women, only 25 percent are registered users of digital services for agriculture. However, it is estimated that plugging this gap, by enabling women to own mobile phones and access the internet, could improve agricultural production by as much as 4 percent and decrease the number of hungry people by up to 17 percent (Kah, n.d.).

Mobile banking services enable the quick and secure transfer of funds, giving producers easier access to markets, reducing their transaction costs and allowing them to tap into new sectors, avoiding costly middlemen. M-Pesa, a mobile banking network developed by Vodafone and Safaricom in Kenya in 2007, was a pilot focused on micro-loans and repayments, but research indicated that consumers primarily used the service for person-to-person money transfers (World Bank, 2017). M-Pesa has grown and now allows producers, traders and consumers to make payments through their phones, reducing the need to travel to and queue in banks to deposit or withdraw money. Its M-Shwari micro-savings facility allows farmers to access credit and pay it back with minimal interest. M-Pesa also allows farmers to sell produce and buy inputs, while consumers can use it to pay for food purchases from farmers, retailers and supermarkets. There are also mobile payment systems to facilitate remittances from urban to rural areas – an increasingly important component of rural livelihoods (Samberg, 2018).

The Kilimo Salama (Swahili for "safe agriculture") scheme provides crop insurance to farmers using the M-Pesa payment gateway, helping them to better manage natural hazards such as drought or excessive rainfall (World Bank, 2012). Similar apps include Sokohewani ("market in the air"), Sokopepe ("virtual market") and SokoShambani ("farmer's market") and are all aimed at linking farmers to markets and other services (World Bank, 2015; Baumüller, 2016). Other mobile marketplaces to connect farmers, agents, buyers and banks include 2KUZE ("let's grow together"), launched by Mastercard and piloted in Kenya, Tanzania and Uganda. Using this platform, smallholders can connect directly with buyers and agents to secure the best price for their goods and receive payment securely through their phones (Ehui, 2018).

FAO has developed numerous digital innovations aimed at bringing young people back to agriculture. The use of drones for fall armyworm monitoring, early-warning systems technology and the Abalobi fisheries app, for example, are all geared to reducing post-harvest losses and/or improving food security in a way that appeals to Africa's youth (FAO, 2018).

CAN DIGITAL TECHNOLOGIES HELP IMPROVE FOOD ENVIRONMENTS AND REDUCE MALNUTRITION IN AFRICA?

As mentioned, 277 million people were estimated to be severely food insecure in Africa in 2019, while the triple burden of malnutrition is particularly prevalent in countries undergoing nutritional transition (FAO, 2019a). Undernutrition and overweight or obesity often coexist due to the increasing consumption of cheap, processed foods that are high in energy, fat and salt content, but low in nutrient quality. Such a diet, ever more common in Africa, fails to tackle chronic undernutrition and micronutrient deficiencies and is fuelling a rise in obesity and diet-related non-communicable diseases (NCDs) (WHO Regional Committee for Africa, 2019).

As demonstrated, digital technologies have been improving food production, post-harvest handling, trade and marketing, all key aspects of ensuring the availability of healthy foods. However, are these improvements in agricultural production leading to more nutritious local diets? Are Africans making better and more nutritious choices, helping to reduce malnutrition is all its forms? To answer these questions, more research is needed on the direct impact pathways involved. But some insights can already be gleaned from the trends observed in digital technology adoption so far. First, digital technologies will need to improve the production of not just any crops, but nutritious crops for dietary diversity. What's more, they need to ensure that these nutritious foods are not only available, but also accessible, affordable and acceptable to the population, so that they translate into actual consumption.

Second, direct nutrition interventions need to be scaled up. Here, digital technologies can help in several ways. A good example is mobile-phone health (mHealth). mHealth is a component of eHealth and is a medical and public health practice supported by mobile devices (WHO, 2011). It has been used both for routine surveillance and in emergency situations. The use of mHealth technology is a growing area in the prevention and management of NCDs and has the potential to deliver health-related behavioural-change interventions (Steinhubl, Muse and Topol, 2013; Opoku, Busse and Quentin, 2019).

Senegal's Ministry of Health, for example, partnered with the World Health Organization (WHO) to improve the collection of maternal health data using Episurveyor, an mHealth app using free data-collection software (WHO, 2011). The GSM Association's (GSMA) mNutrition initiative, meanwhile, has delivered lifesaving maternal and newborn health and nutrition information to more than 1.59 million women and their families in Ghana, Kenya, Malawi, Mozambique, Nigeria, Tanzania, Uganda and Zambia (GSMA, 2018).

Third, improving nutrition outcomes requires building the capacity of nutrition specialists across Africa using digital technology. The Nutrition Society founded the eNutrition Academy (eNA) as a global partnership, with an online platform support by Cambridge University Press, to facilitate shared learning and build capacity for a high-calibre, competent and empowered nutrition workforce for sustainable development (Geissler et al., 2016). WHO's e-library of evidence for nutrition action (eLENA) is another helpful online tool. It is a library of evidence-informed guidelines for an expanding list of nutrition interventions to help countries successfully implement and scale up nutrition interventions (WHO, 2020).

CONCLUSION

Digital solutions for agriculture are important if Africa is to be able to feed itself in 2050. Several digital start-ups and innovations have demonstrated a measurable impact in improving food production, trade and marketing by increasing access to finances, farm inputs, information on weather changes and markets, as well as prices. These technologies can also help to close the gender gap in agriculture and to attract Africa's youth back to farming. At the same time, an increase in agricultural production alone will not lead to better food environments and reduced malnutrition, unless a specific focus on nutritional outcomes is built into agrifood-related technologies and these are used alongside digital solutions to help scale up direct nutrition interventions.

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Digital accountability for the right to food

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INTRODUCTION

Any well-developed human rights system has three major components: (1) rights holders and their rights, (2) duty bearers and their obligations with regard to the rights of the rights holders, and (3) methods of accountability designed to ensure that the duty bearers meet their obligations to the rights holders.

This short essay shows that nationwide computer systems can be used to hold duty bearers to account. The concept is illustrated with the idea of adapting India's Aadhaar system[1] to make its national right-to-food system function more effectively. The idea could be adapted for other settings.

Rights imply entitlements, which are claims to specific goods or services. Rights are – or are supposed to be – enforceable claims. There must be some institutional arrangement through which dissatisfied rights holders can appeal to have the situation corrected. Enforceability means that the duty bearers, tasked with fulfilling those rights, must be obligated to do so and be held accountable for their actions.

In many settings, the local and national courts are viewed as the primary means of calling the government to account if it fails to meet its obligations. However, in practical terms, lawyers and the courts are beyond the reach of most rights holders. When it comes to the implementation of human rights, the most important accountability mechanisms are those directly available to rights holders. These are the local means by which they can take action to ensure that duty bearers do what they are supposed to do to fulfil their obligations. It is through such arrangements that rights systems empower rights holders (Kent, 2019a).

Various right-to-food systems can be devised based on the principles set out in international human rights law (Kent, 2005), national law or a mix of both. For example, right-to-food systems can be established in school-based meals programmes. Children can be told what they are entitled to at each meal. They can be invited to confirm or certify that they have, in fact, received what they are supposed to receive. If their rights are not fulfilled, actions can be taken by those agencies overseeing the programme to ensure that the situation is corrected. With such a system, children are more likely to be well nourished. They are also likely to gain a good understanding of how human rights are supposed to work (Gonçalves and Bellows, 2014; Kent, 2010).

This sort of accountability is often lacking or weak, especially in large-scale rights systems. Under India's version of the right to food, people are entitled to purchase highly subsidized grains at local ration shops. According to a report by Goel (2016), in a village in Rajasthan, the ration shop, five kilometres away, was open only three days a month and generally had long lines of people waiting for their share. Walking to the shop and then waiting, people lost one or more days of work and the income that went with it. Over a one-month period, observers found that 60 percent of eligible families received no rations. The families had no meaningful recourse, no way to challenge the system to get it corrected (Goel, 2016). In India, the distribution of food to which people are entitled has always been erratic and has worsened as a result of the COVID-19 lockdown.[2]

1 The Aadhaar system is the world's largest biometric identity system. Indian residents and passport holders can voluntarily get a unique 12-digit identity number based on their biometric and demographic data.

2 India's non-governmental Right to Food Campaign documents the problems in detail on its website, at http://www.righttofoodcampaign.in/.

Some officials in India believe that dispensing rations through vending machines would be better (Combs, 2019). The machines use India's Aadhaar authentication system to identify those people who receive the rations. The device may help to reduce the misuse of identification data to steal other people's rations, but it is not clear how it would help to ensure the implementation of a person's right to food. Who do you call if the machine is empty or will not accept your identification number?

Whether the transaction is through a vending machine or over the counter at a shop operated by the Public Distribution System,[3] the food entitlement could be "bought" by the rights-holder with a simple swipe of an identity card or a debit card designed for that purpose. The record of that transaction would show that the food in question had, in fact, been delivered to the recipient. Aadhaar-verified receipts can be provided for the supplier as well as the receiver. If the ration shop or the vending machine could not show that rights holders got what they were supposed to get, they should not be paid by the government.

In some postal systems globally, senders can use certified mail to prove that a letter or package has been delivered. Whether the recipients are identified by an Aadhaar number, a social-security number, a passport, a thumbprint or a facial-recognition program, the data collected from the certified receipts can provide a basis for evaluating the performance of the duty bearer (Kent, 2019b). The technology already used to track packages through national and global delivery systems could be adapted to verify that ration entitlement has been delivered. If the system includes information about individuals' identities, such as ethnicity, the system could also be used to detect systematic discrimination (The Hindu, 2020).

In India, accountability mechanisms available to rights holders are known as "grievance redressal mechanisms". The country's Supreme Court has called for the establishment of such mechanisms specifically to ensure the fulfilment of the right to food. The Court acted in response to a claim that people had died of starvation after they were denied rations under the government social welfare scheme due to the absence of an Aadhaar card (Mishra, 2019). Of the 86 people in India reported to have died of starvation between 2015 and 2019, in 46 cases, Aadhaar was directly responsible for the denial of entitlements to the victim's family (Right to Food Campaign, 2019). In effect, rights holders were punished for not having their identity cards, even if it was not their fault. This could be turned around, however: the Aadhaar system could be used to ensure that duty bearers in the system were punished for not properly honouring the legal claims of card-carrying rights holders.

Similar arrangements could be made in all countries to ensure that rights are fulfilled. Problems like those experienced by India's right-to-food programme are encountered in many social-service programmes. These could be strengthened if they were structured as rights-based programmes in which participants had clearly defined entitlements, duty bearers had clearly defined obligations and participants were given access to effective accountability systems to ensure that they got what they were supposed to get. The concept is applicable everywhere. Digital technologies could be used to set up user-friendly means through which rights holders could pursue remedies if their rights appeared to be violated.

Aadhaar is criticized because it gives the government more power over the people, tracking what they do (Business Insider, 2019; Henne, 2019; Pilkington, 2019). However, the system could be adapted to give people more power in relation to to their government. Ensuring that rights are properly fulfilled should be a high priority for all governments and they should be willing to be called to account when rights are violated (Venugopal, 2012; Vivek, 2015). If rights are not enforceable by the rights holders, there is no properly functioning rights system. Digital technologies can be used to empower rights holders if governments are motivated to do so.

3 The Public Distribution System is an Indian food-security system under the Ministry of Consumer Affairs, Food and Public Distribution. It evolved as a means of managing scarcity through the distribution of food grains at affordable prices.

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IFAD/SIMONA SIAD

Tribute

Arne Oshaug

1944 – 2020

by Wenche Barth Eide and Liv Elin Torheim

Arne Oshaug, a true internationalist in the world of food security, nutrition and human rights, died 4 June 2020, aged 75.

Arne had an extraordinary career. After training and working as a chef, he studied nutrition at the University of Oslo and his interests soon turned to the socioeconomic and cultural aspects of access to adequate food. He became involved in a series of innovative interdisciplinary projects in the 1980s, including the development of the first framework for sustainable food security at household level and, from there, defining the right to adequate food as a human right, with its corresponding state obligations. Over the course of 20 years at the University of Oslo, his research included field work in Sri Lanka and Mali. His 1995 doctoral thesis focused on the health of shift workers at petroleum installations in the North Sea, where cardiovascular disease was prevalent. He also began to serve as an advisor to the Norwegian Ministry of Foreign Affairs on various United Nations and international nutrition fora.

In 1998, Arne was enticed by Norway's Ministry of Agriculture to develop integrated approaches to plant, animal and consumer health. Equipped with his frameworks for household food security and the right to adequate food, he exerted significant influence on Norwegian agricultural policy.

In 2000, he was appointed Professor of Public Health Nutrition at Oslo Metropolitan University, where he made a substantial contribution to developing the field as an academic sub-speciality, with research spanning from West-Saharan refugees in Algeria to victims of landslides in Uganda. He was devoted to his students and a very popular lecturer.

In parallel, Arne extended his advisory work for the Norwegian government to the United Nations, not least the United Nations System Standing Committee on Nutrition (UNSCN). From 1999 to 2009, Arne chaired the UNSCN bilateral partners group, providing invaluable support both to the Organization and to global nutrition.
He also worked directly with the Food and Agricultural Organization of the United Nations' Right to Food Unit and with the World Health Organization offices in Geneva and Copenhagen to develop problem-oriented teaching methods on nutrition. He would have loved to be part of current debates on the challenges facing food security and nutrition – debates he, himself had encouraged over the years.

Arne was a generous human being, who provided widespread inspiration and support to colleagues and students. He will be sorely missed by his many friends around the world.

FAO/MARCO PALOMBI

Glossary

3D printing – The construction of a three-dimensional (3D) object from a computer-aided design or digital model.

Aadhaar system – The world's largest biometric identity system. Indian residents and passport holders can voluntarily get a unique 12-digit identity number based on their biometric and demographic data.

Adtech – Short for advertising technology. The adtech ecosystem is a range of software and tools to manage the buying of advertising campaigns by brands and agencies and the selling of advertising inventory by publishers.

Advergame – A form of digital advertising in which a video game is developed by or together with a corporate entity to advertise a brand or branded product.

Algorithm – A set of rules to be followed in mathematical or computer-science calculations or problem-solving operations.

Algorithmic nudging – The use of computer algorithms to predict and influence consumers' online choices and behaviours.

App – Short for application. A small, specialized computer program downloaded to a mobile device, such as a smartphone or tablet, used to access services.

Artificial intelligence (AI) – The ability of a machine to simulate human intelligence and/or perform cognitive functions normally associated with humans, such as learning and problem-solving.

Augmented decision-making – The use of technology and analytics to process data, identify patterns and make recommendations.

Bayesian multi-armed bandit sampling – Also known as Thompson sampling, or randomized probability matching. A method of choosing an action from a limited set of partially known choices to maximize the likely gain.

Big data – A vast amount of data that can be analysed to identify patterns, trends and connections in human behaviour and interactions.

Biometrics – The use of physical or digital information to identify or confirm human features or a person's identity, such as a fingerprint or iris scanner, facial or voice recognition.

Blockchain – Also known as distributed ledger technology (DLT). A decentralized, distributed record of digital assets that enables information on 'blocks' of records to be passed from one digital location to another in a secure, protected and transparent way.

Bluetooth – A wireless technology that allows the exchange of data between fixed and mobile devices over short distances using short-wavelength, ultra-high-frequency radio waves.

Bluetooth beacons – Electronic devices placed in grocery stores, which communicate with apps on shoppers' mobile phones and send information to companies on the amount of time shoppers spend at different grocery aisles.

Bot – Short for robot. An autonomous program on the Internet or another computer network that can interact with systems or users.

Cloud technology – The on-demand delivery of information technology resources, such as data storage, over the internet, without the active management of the user.

Crowdsourcing – The practice of rallying a group for a common goal – often innovation or problem solving – using new technologies, the internet and social media.

Cryptography – Encryption or security protocols used to prevent third parties or the public from reading private communications.

Data crawling – The systematic collection of data from the internet, or any other digital documents or files, usually in large quantities, using a bot (commonly called a crawler or spiderbot).

Data management platform (DMP) – A database with information on particular individuals or devices, collected over time to improve targeted advertising.

Deep learning – A type of machine learning that uses algorithms and artificial neural networks, mimicking the human brain, to teach computers to learn. Deep learning uses multiple layers of raw data to extract and identify complex features, to recognize faces or images, for example.

Deep neural network (DNN) – A complex neural network with multiple layers that uses sophisticated mathematical models to process data in complex ways. DNNs are used for acoustic and visual recognition, to filter spam sent through electronic communications and to recognize sentiment in customer feedback.

Deep recurrent neural network (DRNN) – A type of neural network that contains multiple loops, allowing information to be stored in hidden layers within the network, commonly used in speech recognition.

Demand-side platform (DSP) – A technical bidding tool used by marketing agencies or brands to improve the targeting of advertisement and increase the likelihood that the advertisement will reach users who have an interest in buying.

Digital age – Also called the information age or digital revolution. The period since the 1970s, when the personal computer was introduced, facilitating the rapid transfer of information through the internet and electronic devices.

Digital commerce - Also called e-commerce or eCommerce. The use of the internet, mobile technology and social-media platforms to facilitate a business transaction, such as shopping.

Digital divide - The difference in or inequity of an individual or population's access to and use of information and communication technologies due to social, geographic, economic or political factors.

Digital literacy –The ability and skills to find, evaluate, create and communicate information effectively using digital technologies and platforms.

Digital marketing – The promotion and advertisement of brands and products through digital platforms, mobile apps and electronic devices connected to the Internet.

Digital media – Information that is coded in machine-readable format (text, audio, video or graphics) and shared or transmitted through the internet or other communication platforms, such as television or smartphones.

Digital native – A term often used to refer to a person born or raised during the digital age who is familiar with computers and digital devices from an early age.

Distributed ledger technology (DLT) – See blockchain.

eCommerce – See digital commerce.

eHealth – Healthcare practice supported by electronic processes and online communication technology.

eLearning – Learning conducted through electronic media and the internet.

Full-stack technology – Refers to an entire computer system, from the front-end (user-facing) technology to the back-end (behind-the-scenes) technology, as well as the connecting software.

Fuzzy logic – An approach to computing based on "degrees of truth" rather than the "true or false" (1 or 0) Boolean logic on which the modern computer is based.

Geofencing – A location-based digital marketing tool that allows companies to send messages to shoppers when smartphones are near or inside stores in a specific geographic area.

Geolocation – Identifying the geographical location of a person or device using digital information processed via the internet.

Global positioning system (GPS) – A navigation system that uses satellites, receivers and algorithms to provide location, navigation and timing information.

Image Capture – An app for iOS devices (manufactured by Apple Inc.) that enables users to upload pictures from digital cameras or scanners that are connected directly to a computer or network.

Image scraping – The use of bots or programs to collect and download images, usually in large quantity, from websites.

Immersive reality – Also known as immersion. Virtual reality technology that gives the user the sense of being physically present in a non-physical world. See virtual reality.

Implementation science – The scientific study of methods and strategies to enhance the uptake and use of evidence in policy and practice to optimize population health.

Influencer – A person who creates and shares content online, commonly through social-media platforms, and is able to influence the choices and behaviours. Influencers commonly promote or recommend brands, products or services to steer potential customers to businesses that sponsor them.

Informatization – The process by which new information and communications technologies are used to further a country's socioeconomic development.

Industrial Internet of Things – A system of interconnected sensors, instruments, machines and other devices for industrial applications, such as manufacturing or energy management, to transfer data automatically through a digital network.

Internet of Things – A system of interrelated products, devices or objects that can connect to the internet and transfer data through digital networks without human-to-computer interaction.

Interoperability – The ability of different information systems, devices and applications to access, exchange, integrate and use data in a connected and coordinated way.

Learning management system – A software application to automate, document, track, monitor and deliver educational courses and training programmes.

Machine learning – An application of AI that enables systems to automatically learn and improve from experience.

mAgri – Short for mobile agriculture. Used to describe the use of apps for mobile devices, such as smartphones and tablets, and similar digital technology in agriculture.

mHealth – Short for mobile health. Used to describe the practice of medicine and public health supported by mobile devices, such as smartphones or tablets.

Microbiome – The total genetic material of all the microbes that live on and inside the human body.

Microcelebrity – A person who gains a niche, cult or mainstream following due to viral internet or social-media distribution.

Natural language processing (NLP) – A branch of AI that deals with the interactions between computers and human (natural) languages in order to program computers to process and analyse large amounts of human language data.

Neural network – A series of algorithms that recognizes the fundamental relationships in a set of data in the same way as the human brain.

Part-of-speech tagging – The process of marking a word in a text to correspond to a certain part of speech based on definition and context.

Precision agriculture (satellite farming) – The use of digital technologies to create a decision-making support system to enable farmers to observe, measure and respond to changes in crops or animals, so as to manage and optimize outputs and use resources efficiently.

Programmatic advertising – The automated buying and selling of online advertising.

Quantum computing – A new idea of computing that uses the laws of quantum mechanics to solve problems far quicker than classical computing.

R software – Free software for statistical computing and graphics, widely used by statisticians and data miners in statistical and data analysis.

Radio frequency identification – A form of wireless communication that uses electromagnetic fields to identify and track tags attached to objects.

Recurrent neural network (RNN) – A type of neural network commonly used in handwriting or speech recognition and natural language processing.

Region-based convolutional neural network (R-CNN) – A convolutional neural network (CNN) is a class of deep neural network typically used to analyse visual imagery. Region-based CNNs (R-CNNs) are specialized CNNs used in computer vision and object detection.

Social media – Digital platforms, commonly in the form of apps or websites, that allow users to create and share content or engage in social networking.

Social networking – The use of websites, online platforms and applications to communicate and interact with people or online groups who share similar interests.

Supply-side platform (SSP) – A media business that uses technology tools to automate the sale of digital advertising, in order to achieve high returns for advertisers.

Surveillance capitalism – A market-driven process of collecting, analysing, selling or commodifying one's personal biometric data and online behaviours for profit.

Tagging – Assigning a keyword or term to a piece of information, such as a computer file, which allows it to be identified by online browsing or searching.

Virtual reality (VR) – Computer-simulated environments or experiences, commonly used for entertainment or educational purposes, which shut out the physical world. See immersive reality.

Visible-light fluorescence spectroscopy - A process that uses a beam of light to stimulate the electrons in the molecules of certain compounds, causing them to emit light, which can then measured and used to identify the substance or changes in the substance.

'Walled-garden' advertising platform –A network of sufficient size and power (Google, Facebook or Amazon, for example) with its own technology platforms that are not open to other publishers or technology companies, but that could be sold as an advertising network to advertisers.

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A world free from hunger and all forms of malnutrition is attainable in this generation

UNSCN

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