Evaluating the effectiveness of a participatory video education intervention on critical nutrition literacy of adolescent girls in rural Ghana

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December 2022

A dissertation submitted to McGill University

in partial fulfillment of the requirements for the degree of Doctor of Philosophy

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Abstract

The Ottawa Charter for Health Promotion underscores the need to change both individual behaviour and social determinants of health to sustain behaviour change – concurrently highlighting the construct of critical literacy. Critical nutrition literacy refers to the knowledge, skills, and confidence to change personal lifestyle and environmental factors to improve nutrition. Its promotion has been seldom investigated among adolescents. The central aim of this dissertation was to understand how critical nutrition literacy can be enhanced in adolescents by investigating a novel nutrition education approach. A participatory video-making approach can enable youth to make short films about issues affecting their lives. Adolescents are given control of the video-making process – they identify the topic, develop the content, act, film, and screen their video. A participatory video-making approach may be used to help enhance critical nutrition literacy because it helps adolescents reflect on nutritional issues, foster dialogue, and build agency to participate in social change. The dissertation's first objective was to evaluate the effectiveness of a participatory video intervention on adolescent critical nutrition literacy and dietary behaviours. A 2018-19 cluster randomized controlled trial (ClinicalTrials.gov NCT03704649) selected 20 schools in one Ghanaian rural district and enrolled 351 girls, 13-16 years of age (10 intervention, n=181; 10 control, n=170). All schools received a nutrition curriculum for their girls' clubs. The 181 girls in the 10 intervention schools also engaged in participatory video-making activities. Each intervention school developed a cognitive map and produced a video on the most pressing challenge they identified to getting a balanced diet. The process was repeated for challenges linked to consuming iron-rich foods. To assess the effectiveness of the intervention, all research participants answered baseline and endline surveys that measured nutrition literacy, food purchasing habits, and dietary intake. Critical nutrition

literacy was measured using 10 self-assessment statements that resulted in responses on a five-point Likert scale from strongly disagree to strongly agree. Each statement response was made into a dichotomous variable (0 = not critically literate, 1 = critically literate) and a cumulative score for the 10 items was tabulated (range 0 to 10). Using a simple majority as the predetermined threshold, the cumulative score was dichotomized (<6 = not critically nutrition literate; ≥ 6 = critically nutrition literate). A similar approach was taken for other nutrition literacy indicators and food knowledge. Food group consumption of dark green leafy vegetables and animal-sourced food was documented using a non-quantitative food frequency questionnaire. An intent-to-treat analysis assessed the intervention effect on critical nutrition literacy and secondary outcomes using general linear mixed models with cluster-level random effects (CIETmap 2.2 software). Exposure to the participatory video intervention led to a 4-fold increase in critical nutrition literacy (AOR= 4.24; 95% CI: 2.02, 8.87). There were also significant differences in interactive nutrition literacy (AOR= 5.52; 95% CI: 2.21, 13.78) and functional nutrition literacy (AOR= 2.14; 95% CI: 1.05, 4.33). Results show significant group differences in knowledge about balanced diet (AOR= 7.31; 95% CI: 2.38, 22.50) and iron-rich food (AOR= 6.44; 95% CI: 1.21, 34.38). Moreover, when asked about their food choice when purchasing a meal for themselves, intervention participants chose more balanced (AOR= 8.92; 95% CI: 1.49, 53.48) and iron-rich meals (AOR= 11.77; 95% CI: 2.32, 59.78). There were no group differences in daily food consumption of dark-green leafy vegetables, meat, and fish. The second dissertation objective was to work with adolescent girls to identify their challenges in getting a balanced diet and iron-rich food in rural Ghana. Each intervention school produced a cognitive map and video of the challenges they faced for each topic. An inductive thematic analysis of the cognitive maps and videos was completed to consolidate adolescent girls'

common challenges. This analysis showed that adolescents' agency was limited by their lack of decision-making power at home and purchasing power at school. When they could make their own food choices, their decisions were influenced by their lack of nutrition knowledge and preferences and limited availability of animal-sourced foods, fruits, and dark green leafy vegetables. The availability of these nutrient-rich foods was shaped by the knowledge and priorities of gatekeepers of adolescent diet - parents at home and canteen staff at school. For example, common family agricultural practices of cutting down and spraying dark green leafy vegetables with weedicide negatively affected the availability of iron-rich food in the home. Finally, the third dissertation objective was to assess the perceived value of participatory video-making among intervention participants and local stakeholders. Here, an iterative participatory evaluation approach called the Most Significant Change method was used. Project staff collected 116 stories of change from intervention adolescents after endline. Adolescents described shifts in four domains: participant, peer, and family behaviour, and structural changes in the school. The project team used a selection rubric to identify 14 stories demonstrating heightened nutrition literacy. Staff conducted in-depth interviews with the 14 adolescents whose stories were selected to elaborate on details and perceived resonance. Finally, a community advisory board reviewed and assessed the 14 stories and chose four – one per domain. A separate thematic analysis of the 14 interviews identified emerging patterns of adolescents' motivation and action. The stories of change revealed that the intervention promoted a transformative influence; participants modified their nutrition-related behaviour and environment. The four Most Significant Change stories demonstrated how adolescents found creative solutions to acquire iron-rich food, encouraged neighbours to eat iron-rich food, taught their family new agricultural practices and promoted change in their school canteen. This dissertation provided evidence of the added value of a

participatory video-making intervention in nutrition education among adolescents. The participatory video-making intervention provided a framework for adolescents to improve critical nutrition literacy, food knowledge, and food choices. Intervention participants explored their diet-related challenges and devised solutions. Finally, they were inspired to act and teach others for the betterment of their peers, families, and communities. In so doing, the participatory video-making nutrition education intervention provided a viable model for adolescent girls to enhance critical nutrition literacy and to be agents of change in their community. Notwithstanding, parents and canteen staff remain key gatekeepers to adolescent diet. Adolescent nutrition interventions should include strategies to reach their caregivers and school staff.

Résumé

Évaluation de l'efficacité d'une intervention éducative par vidéo participative sur la littératie critique en nutrition des adolescentes dans une région rurale du Ghana

La charte d'Ottawa pour la promotion de la santé souligne la nécessité de modifier à la fois le comportement individuel et les déterminants sociaux de la santé afin de maintenir le changement de comportement, tout en mettant en évidence le concept de littératie critique. La littératie critique en nutrition (LCN) fait référence aux connaissances, aux compétences, et à la confiance en soi nécessaires pour changer son mode de vie et son environnement afin d'améliorer la nutrition aux niveaux individuel et communautaire. Sa promotion a été rarement étudiée chez les adolescents. L'objectif central de cette thèse était de comprendre comment la littératie critique en nutrition peut être améliorée chez les adolescents en étudiant une nouvelle approche d'éducation nutritionnelle. Une approche participative de la réalisation de vidéos peut permettre aux jeunes de réaliser des courts-métrages sur des questions touchant à leur vie.Les adolescents ont le contrôle du processus de réalisation de la vidéo - ils identifient le sujet, développent le contenu, agissent, filment et projettent leur vidéo. Une approche participative de la réalisation de vidéos peut être utilisée pour aider à améliorer la littératie critique en matière de nutrition parce qu'elle aide les adolescents à réfléchir sur les questions de nutrition, à encourager le dialogue et à construire une agence pour participer au changement social. Le premier objectif de la thèse est d'évaluer l'efficacité d'une intervention par vidéo participative sur les LCN et les habitudes alimentaires des adolescentes. En 2018-2019, dans le cadre d'un essai contrôlé randomisé par groupe (ClinicalTrials.gov NCT03704649), 20 écoles ont été sélectionnées dans une région rurale ghanéenne et 351 filles, âgées de 13 à 16 ans, ont été inscrites (10 intervention, n=181; 10

groupe-contrôle, n=170). De Toutes les écoles ont reçu un programme de nutrition pour leur club de filles. Les 181 filles des 10 écoles d'intervention ont également participé à des activités de création de vidéo participative. Chaque école d'intervention a élaboré une carte cognitive et produit une vidéo sur le défi le plus urgent identifié pour avoir une alimentation équilibrée. Le processus a été répété pour les défis liés à la consommation d'aliments riches en fer. Afin d'évaluer l'efficacité de l'intervention, les participantes ont répondu à des enquêtes de début et de fin qui ont permis de mesurer la littératie en nutrition, les habitudes d'achat de nourriture et les apports alimentaires. La LCN a été mesurée à l'aide de 10 énoncés d'auto-évaluation qui ont donné lieu à des réponses sur une échelle de Likert en cinq points (fortement en désaccord à fortement en accord). La réponse à chaque énoncé a été interprétée en une variable dichotomique (0 = manque de littératie critique en nutrition – 1, = littératie critique en nutrition), puis un score cumulatif pour les 10 énoncés a été établi (intervalle de 0 à 10). En utilisant une majorité simple comme seuil prédéterminé, le score cumulé a été dichotomisé (<6 = manque de littératie critique en nutrition ; ≥ 6 = littératie critique en nutrition). Une approche similaire a été adoptée pour d'autres indicateurs de littératie en nutrition, ainsi que pour les connaissances en alimentation. La consommation de groupes d'aliments (c'est-à-dire au moins une fois par jour) de légumes à feuilles vert foncé et d'aliments d'origine animale a été mesurée à l'aide d'un questionnaire de fréquence alimentaire non quantitatif. Une analyse en intention de traiter a évalué l'effet de l'intervention sur la LCN et les résultats secondaires à l'aide de modèles mixtes linéaires généraux avec effets aléatoires au niveau du groupe (logiciel CIETmap 2.2). L'exposition à l'intervention par vidéo participative a permis de quadrupler la LCN (AOR= 4,24; IC à 95%: 2,02 - 8,87). Il y avait également des différences significatives dans la littératie en nutrition interactive (OR = 5,52 ; IC à 95 % : 2,21 - 13,78) et la littératie en nutrition fonctionnelle (OR =

2,14 ; IC à 95 % : 1,05 - 4,33). Les résultats montrent des différences significatives entre les groupes dans les connaissances sur l'alimentation équilibrée (AOR = 7,31 ; IC à 95 % : 2,38 - 22,50) et les aliments riches en fer (AOR = 6,44 ; IC à 95 % : 1,21 - 34,38). De plus, lorsque les adolescentes ont été interrogées sur leurs choix alimentaires lors de l'achat d'un repas pour elles-mêmes, les participantes à l'intervention ont affirmé avoir choisi des aliments plus équilibrés (AOR = 8,92 ; IC à 95 % : 1,49, 53,48) et riches en fer (AOR = 11,77 ; IC à 95 % : 2,32, 59,78). Il n'y avait pas de différences entre les groupes en ce qui concerne la consommation quotidienne de légumes à feuilles vert foncé et d'aliments d'origine animale. Le deuxième objectif de la thèse était de travailler avec des adolescentes pour identifier les défis communs auxquels les adolescentes doivent faire face pour obtenir une alimentation équilibrée et des aliments riches en fer dans une région rurale du Ghana. Chaque école d'intervention a produit une carte cognitive et une vidéo des défis qu'elle a rencontrés pour chaque sujet. Une analyse thématique inductive des cartes cognitives et des vidéos a été réalisée pour consolider les défis communs auxquels les adolescentes étaient confrontées au sein et au travers des deux sujets. Les résultats montrent que l'action des adolescentes était limitée par leur manque de pouvoir décisionnel à la maison et de pouvoir d'achat à l'école. Lorsqu'elles pouvaient faire leurs propres choix alimentaires, leurs décisions étaient influencées par leur manque de connaissances et de préférence en matière de nutrition ainsi que par la disponibilité limitée des aliments d'origine animale et des légumes à feuilles vert foncé. La disponibilité de ces aliments riches en nutriments était déterminée par les connaissances et les priorités des responsables de l'alimentation des adolescentes, soit les parents à la maison et le personnel de la cantine à l'école. Par exemple, les pratiques agricoles familiales courantes consistant à couper et à pulvériser des herbicides sur les légumes à feuilles vert foncé ont eu un impact négatif sur la disponibilité des aliments riches en fer à la maison. Enfin, le

troisième objectif de la thèse était d'évaluer l'influence et la valeur perçues de l'intervention parmi les participants à l'intervention et les intervenants locaux. Ici, une approche d'évaluation participative itérative appelée “la méthode du changement le plus significatif” a été utilisée. Le personnel du projet a recueilli 116 histoires de changement auprès des adolescentes ayant fait l’objet de l'intervention après la fin du projet. Les adolescentes ont décrit des changements dans quatre domaines : le comportement des participantes, des pairs et de la famille et les changements structurels à l'école. L'équipe du projet a utilisé une grille de sélection pour identifier 14 histoires qui démontraient une meilleure connaissance de la nutrition. L'équipe a mené des entretiens avec les 14 adolescentes dont les histoires ont été sélectionnées afin d'approfondir les détails et la résonance perçue. Enfin, un comité consultatif communautaire a examiné et évalué les 14 histoires et en a choisi quatre - une par domaine. Une analyse thématique distincte des 14 entretiens a identifié les modèles émergents de motivation et d'action des adolescentes. Les histoires de changement ont révélé que l'intervention a favorisé une influence transformatrice; les participantes ont modifié leur comportement lié à la nutrition et leur environnement. Les quatre histoires de changement les plus significatives choisies ont révélé comment les adolescentes ont trouvé des solutions créatives pour acquérir des aliments riches en fer et encouragé leurs voisins à en manger ; elles ont enseigné à leur famille de nouvelles pratiques agricoles et ont promu le changement dans leur cantine scolaire. Cette thèse démontre la valeur ajoutée d’une intervention éducative par vidéo participative sur la littératie critique en nutrition des adolescentes. En conclusion, l'intervention par vidéo participative a fourni un cadre aux adolescentes pour 1) explorer les défis liés à l'alimentation auxquels elles étaient confrontées et concevoir des solutions possibles, 2) améliorer les connaissances essentielles en nutrition, leurs connaissances alimentaires et leurs choix alimentaires et 3) inspirer les adolescents à agir et

à enseigner aux autres pour l'amélioration de leurs pairs, de leurs familles et de leurs communautés. Ce faisant, l'intervention éducative par vidéo participative en matière de nutrition a fourni un modèle viable pour les adolescentes qui leur permet d'améliorer leurs connaissances essentielles en nutrition et de devenir agentes du changement dans leur communauté. Néanmoins, les parents et le personnel des cantines restent les principaux conservateurs de l'alimentation des adolescentes. Les interventions visant à promouvoir la nutrition chez les adolescentes doivent inclure des stratégies pour atteindre les personnes qui s'occupent d'elles et le personnel de l'école.

Acknowledgements

These accomplishments are not mine alone - nothing can be further from the truth. Many have played important roles in shaping and contributing to my work - many whose names may not appear in these pages. This doctoral research was conducted in the Upper Manya Krobo district of Ghana, on the land of the Indigenous Krobo tribe, and written, in part, in the unceded and unsurrendered territory of the Kanein:keha'ka nation in Tiohtià:ke/Montréal, Canada. I acknowledge the original inhabitants of these great lands and express my appreciation for their wisdom and hospitality.

I must thank those who have guided me, worked with me, and stood beside me. Words cannot describe my gratitude for my supervisor, Dr. Grace Marquis. Her work ethic, generosity, and love for research have enriched my doctoral experience. She was always there in times of need, jumping on a quick call or problem-solving for hours together at the dining room table in Asesewa. She was also present to celebrate the successes, going out of her way to visit and applaud the girls who completed their videos. I am so lucky to have her as an example, a mentor, and a friend. I extend my admiration and gratitude to my committee members Dr. Neil Andersson and Dr. Naa Dodua Dodoo for their patience and thoughtful feedback. They were always there to offer assistance and a gentle word of encouragement whether helping me learn new statistical software or accompanying me in meetings with Research Ethical Boards. I could not have done this without their guidance and support.

I have learned from many researchers who have shared their expertise and their love for science. A special thanks to Dr. Roger Cue who helped demystify quantitative statistical methods and was always ready to listen to my queries. Thanks to Dr. Bridget Aidam who encouraged and

supported me while collecting qualitative data for the first time; Dr. Claudia Mitchell who shared her wisdom and passion for participatory visual methodologies; Dr. Ashley Naimi and Alea Morren for providing a well-needed refuge; and to Dr. Victoria Talwar for opening her home and helping me untangle the ends of my dissertation. Also, colleagues in Dr. Marquis' and Dr. Andersson's respective labs have contributed their time and feedback to help improve my work. Special thanks to Karim Bougma, Husein Mohammed, Diana Dallmann, Yvonne Goh, Myriam Benchiba, Elahe Sharbabak, Priscilla Boadi, Aisha Abdu, Meray Arnouk, and Prerana Adhikari. I have learned so much from them and cherish their friendship.

My experiences with several organizations have shaped my intervention and research activities. I was inspired by my field visit to Lucknow, India where I conversed with community health workers and adolescents about their experience with the *Projecting Health Initiative.* Their use of participatory videos in health promotion helped me see new possibilities in community-based nutrition education. A special thanks to *InsightShare* in Oxford, England for providing inspiring hands-on training on implementing a participatory video methodology. A big thank you to *World Vision Ghana* for providing me the opportunity to learn about qualitative research with a motivated team across rural Ghana. Thank you to the *Olinga Foundation* and *Associates for Change* for their openness and eagerness to learn new things. I appreciated learning together about how a participatory video-making approach can be implemented in education interventions, and to apply it together in Suhum, Ghana. Finally, to the *Junior Youth Empowerment Program*: thank you for widening my vision of what is possible in community development, reinforcing my conviction of the capacities of youth, and providing me a framework to learn and serve alongside my neighbours.

This research could not have been done without the efforts of our Community Advisory Board members: Felix John Quaye, Peter Tetteh Lamptey, Victoria Barku, Emmanuel Kojo Sackey, and Tettey Felix Tetteh. I am grateful for the tireless work of our project staff: Florence Teye, Regina Mamle Tettey, Grace Nyumu-Teye, and Mary Sackitey Sackie, and to all the headmasters, girl child coordinators, and traditional leaders that embraced this project as their own. I feel grateful to have shared this passion with you, to have worked alongside you, and to have learned so much from you. I feel blessed to have gained new family members in Ghana. To my Auntie Leslie, Uncle Leo, Auntie Kate, Uncle Samuel, Layli, and Lua: you welcomed me, opened your hearts, and made me feel at home. I cherish those friendships and look forward to seeing you again.

I must thank my friends who have inspired, encouraged, and sustained me throughout this journey. I could not have completed this doctoral training without your friendship, words of encouragement, and sweet gestures of support. Thank you to Saba, Clara, Sepideh, Mona, Tara, Mitra, Jenna, Anne, Samira, Ilona, Awal, Althaqib, Ezgi, Nasim, Adora, Neysan, Sholeh, Sohayl, Maral, Melinda, Faran, my Walkley family, and so many more. I appreciate every work date, every pep-talk, every time you listened to a presentation, proofread a document, helped me with my references, or travelled half-way across the globe to spend time with me in Ghana. I hope I can reciprocate your generosity, and I hope this accomplishment feels like your own – I could not have done it without you.

I am indebted to my family. To my grandmother, Nana Sharbanoo, who was imprisoned for promoting the education of girls, to her sons and daughter who valued the equality of women and men, and to family members that have seized every opportunity to learn and to educate – thank you for inspiring me. A special note to my three uncles, Esmail, Abdu'l-Missagh, and

Esfandiar, who along with my father were the first in our family to pursue higher education and to leave a profound and lasting legacy in their fields. To my niece, Leili joon: I have been doing this doctoral training for the majority of your life. I am so grateful for your patience, and for the sweet ways you have encouraged me along the way. Every long-distance call, every encouraging note, and every hug has sustained me and filled this journey with joy. To my sister, Hoda joon: thank you for encouraging me, advocating for me, and for being such a pillar of strength and love. To my Mama joon: thank you for being an example of calm determination and for always making me smile. You have supported me and encouraged me every step of the way – thank you. Finally, I must thank my father, Baba joon, whose love for research and nutrition has fueled my desire to contribute to scientific inquiry. Thank you for being proud of my smallest accomplishments and reminding me that the title of a doctorate means nothing without the passion for wanting to contribute to the welfare of others. Although he passed before I enrolled, I felt him beside me every step of the way.

Finally, to the adolescents who dedicated their time to this project, I am in awe of you. I hope my humble attempt to describe your efforts in these pages does your work justice. It was an honour to learn from you and to witness all you have accomplished. I feel so lucky to have witnessed your thirst of knowledge, your humility and courage. When given the opportunity, you showed so much capacity and desire to create change. You have reinforced my conviction that youth really need to be at the forefront of community transformation.

Funding acknowledgement

The doctoral research was made possible thanks to the Canadian Queen Elizabeth II Diamond Jubilee Scholarships (QES) in collaboration with Universities Canada, Rideau Hall Foundation, Community Foundations of Canada, and Canadian universities. The QES-Advanced Scholars

Program was made possible with financial support from International Development Research Centre and Social Sciences and Humanities Research Council. I am especially grateful to the QES-Advanced Scholars Program and its administrators for funding my efforts to share the videos more widely in the community after data collection was completed. With their support, we were able to have Asesewa's first Nutrition Film Festival and twenty decentralized video screenings with over 800 school staff, students, parents and traditional leaders across the district. I would also like the thank the McGill Graduate Mobility award, who funded my visit to *Projecting Health Initiative's* field site in Lucknow, India, as well as my training with *InsightShare* in Oxford, United Kingdom.

Dedication

This doctoral thesis is dedicated to the women in my family,
with great appreciation for my grandmother and ameh Ziba who fought for the education of girls
and with earnest anticipation to see what the new generation will accomplish.

And to my parents, Parviz and Golrokh Ghadirian,
I love you more than all the stars in the sky, and the sun, and the moon.

Contribution to original knowledge

This doctoral dissertation provides empirical evidence to support the use of a participatory video intervention as a model for nutrition education and participatory research. It contributes to the field of adolescent nutrition, nutrition education and behaviour change, nutrition literacy as well as research around the influence of participatory video-making.

This dissertation aimed to test the effectiveness of a participatory video nutrition education intervention on the nutrition literacy, food knowledge, and dietary behaviour of adolescent girls. An intervention that uses a participatory video-making approach was developed and was tested within the context of a cluster randomized controlled trial (cRCT). The intervention arm of this cRCT produced cognitive maps and videos about obstacles they faced to getting balanced meals and iron-rich food, and screened their videos to their classmates. They then reflected on changes in behaviour they may have witnessed since their screenings.

There are recent studies that have looked at the positive influence of using participatory videos as a medium for nutrition education. Such studies have focused on the influence of watching participatory videos on audiences' food knowledge and dietary behaviours. This study builds on this body of research and provides a unique perspective on the positive influence of the video-making process on video creators' nutrition literacy, food knowledge, and dietary behaviour. The results of the cluster randomized controlled trial are presented in **Chapter 3** (Manuscript 1). It is the first reported trial, that we are aware of, that investigated the influence of a participatory video-making intervention on the nutrition literacy of youth creators.

Chapter 4 (Manuscript 2) explored the perceived challenges adolescent girls faced in getting a balanced diet and iron-rich food in rural Ghana. This study conducted an inductive thematic analysis of the aforementioned cognitive maps and videos that were made by adolescents during the intervention activities. The results contribute to our understanding of adolescent food environments and their perceived influence on adolescent diet. Though participatory visual research methodologies like photovoice are gaining popularity in the field of nutrition, this is one of the first reported trials of a participatory video intervention that we are aware of, that explored challenges in adolescents' food environments with youth creators.

Finally, **Chapter 5** (Manuscript 3) presented the use of the Most Significant Change methodology, a participatory evaluation approach. It was used to assess the perceived value and influence of the participatory video intervention among adolescent participants and local stakeholders. This study presented evidence that participatory video nutrition education resulted in a transformative change; participants modified their eating habits, lifestyle, and their environment. This study provides further evidence of the influence of a participatory video intervention on participants' behaviour, and that of their peers, families, and schools.

Contribution of authors

This dissertation presents elements of a cluster randomized controlled trial that assessed the effectiveness of a nutrition education intervention in rural Ghana. I am the primary investigator for this clinical trial (ClinicalTrials.gov NCT03704649). In this role, I designed the intervention activities, research protocol, and data collection tools. I applied for and obtained funding. I also applied and obtained ethical clearance from University of Ghana's Ethics Committee for the Humanities and McGill University's Research Ethics Board-III. I coordinated the implementation of the research protocol and spearheaded the data analysis presented in this dissertation.

This dissertation presents three scholarly papers that address a common research aim – to understand how critical nutrition literacy can be enhanced in adolescents. The three manuscripts presented in Chapter 3, 4, and 5 have been co-authored with Dr. Grace Marquis, Dr. Naa Dodoo, and Dr. Neil Andersson. Dr. Marquis provided academic guidance as the candidate's doctoral supervisor. She played a key role in informing the research design and implementation and provided input and revisions for all the chapters in this dissertation. Dr. Dodoo and Dr. Andersson provided valuable support in refining the research design and data analysis. All co-authors contributed input, revised, and approved the manuscripts prior to submission.

Manuscript 1. Participatory video intervention increased critical nutrition literacy of Ghanaian adolescent girls: a cluster randomized controlled trial
Ghadirian MZ, Marquis GS, Dodoo ND, Andersson N

(Intention to submit to The Journal of Nutrition)

I designed the intervention activities, research protocol and developed the survey questionnaire using Open Data Kit software. I applied for and obtained funding and ethical clearance and registered the clinical trial. I trained project staff in intervention and research protocol and coordinated its implementation. As lead author, I analyzed the data and drafted the manuscript. Dr. Grace Marquis provided guidance and advice in the study design and implementation of the research protocol. Dr. Grace Marquis and Dr. Neil Andersson provided advice on data analysis. All authors contributed to, reviewed, and approved the final manuscript.

Manuscript 2. Adolescent girls' perceived barriers to a balanced diet and iron-rich food in rural Ghana: grounded theory from a participatory video intervention

Ghadirian MZ, Marquis GS, Dodoo ND, Andersson N

(Under review in the Journal of Global Health: Science and Practice)

I designed and coordinated the fieldwork, obtained funding and ethical clearance. As lead author, I analyzed the cognitive maps, conducted video analysis, and drafted the manuscript. Dr. Grace Marquis, Dr. Neil Andersson, and Dr. Naa Dodoo provided advice in the study design and data analysis. All authors contributed to, reviewed, and approved the final manuscript.

Manuscript 3. (Chapter 5) Ghanaian female adolescents perceived changes in nutritional behaviors and social environment after creating participatory videos: a Most Significant Change evaluation

Ghadirian MZ, Marquis GS, Dodoo ND, Andersson N

(Published in Current Developments in Nutrition)

I designed and coordinated the intervention and research protocol, obtained funding and ethical clearance. I conducted the focus group discussion during the final selection of stories and the analysis of the in-depth interviews. As lead author, I drafted the manuscript and communicated with the journal staff at Current Developments in Nutrition. Dr. Grace Marquis, Dr. Neil Andersson, and Dr. Naa Dodoo provided advice on the study design and analysis. All authors contributed to, reviewed, and approved the final manuscript.

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List of abbreviations

AOR	Adjusted odds ratio
CAB	Community advisory board
CFC	Community Foundations of Canada
CNL	Critical nutrition literacy
cRCT	Cluster randomized controlled trial
DALY	Disability-adjusted life year
FNL	Functional nutrition literacy
GIFTS	Girls' Iron-Folate Tablet Supplementation
GLMM	General linear mixed model
IDA	Iron deficiency anemia
IDRC	International Development Research Centre
INL	Interactive nutrition literacy
ITT	Intention-to-treat
JHS	Junior high school
LMIC	Low- and middle- income country
MSC	Most Significant Change
NSA	Nutrition-sensitive agriculture
OR	Odds ratio
PI	Primary investigator
PR	Prevalence ratio
PV	Participatory video
QES	Queen Elizabeth Scholarship
REALM-Teen-S	Rapid Estimate of Adolescent Literacy in Medicine Teen-Shortened
REB	Research ethics board
SPRING	Strengthening Partnerships, Results, and Innovations in Nutrition Globally
SSHRC	Social Sciences and Humanities Research Council
UMKD	Upper Manya Krobo District
WRA	Women of reproductive age

CHAPTER I. Introduction

Background and rationale

Adolescence is a distinctive life stage marked by increased nutritional needs to support rapid growth, and opportunities to develop capabilities and dietary habits that can persist throughout life (Cruz et al., 2018; Frech, 2012). Thus, adolescence presents a window of opportunity to foster healthy eating habits that can contribute to current physical and cognitive development as well as positive health outcomes in adulthood (Bhutta et al., 2017). Global trends in adolescent malnutrition give one ample reason to be concerned. Since 1975, there has been a minimal global decline in iron deficiency anemia (IDA), underweight, and stunting in adolescent girls, and overweight has increased (Abarca-Gómez et al., 2017; Akseer et al., 2017). Despite this, adolescent nutrition research has been underinvested in comparison to other age groups (Norris et al., 2021). There is insufficient research about adolescent diet, food environments, and the factors that influence adolescent food choices (Neufeld et al., 2021). Subsequently, there is a lack of research about evidence-based interventions and policies to address adolescent malnutrition. An in-depth understanding of individual and environmental drivers of adolescent diets is needed to inform adolescent nutrition-sensitive interventions.

Though nearly 90% of the world's adolescents reside in low- and middle-income countries (LMICs), very few studies have looked at adolescent food environments in LMICs (Carducci et al., 2021). Traditional food environments are prominent in rural LMIC settings, where people rely mainly on growing their own food and purchasing food from local markets and kiosks (HLPE, 2017). Understanding adolescents' diet-related challenges in traditional food environments may provide vital information to tailor programs and policies that can influence a great majority of the world's adolescent population (Neufeld et al., 2021).

In Ghana, the prevalence of stunting and thinness has remained stagnant from 2003 to 2014 among adolescent girls, overweight and obesity is increasing, and over 25% of non-pregnant adolescent girls, 15-19 years of age, were anemic in 2017 – signaling a national public health concern (Azupogo et al., 2021; University of Ghana et al., 2017). The country has been experiencing a nutrition transition. This includes changes in food systems, food availability, and dietary behaviour (Rousham et al., 2020). From 1971 to 2018, Ghanaians reduced their consumption of fruits and vegetables and increased their consumption of processed foods like nutrient-poor sugar-sweetened beverages (Rousham et al., 2020). Adolescent girls in LMICs like Ghana have reported high consumption of energy-dense nutrient-poor foods and low dietary intake of dairy, meats, fruits, and vegetables (Atsreh Buxton, 2014; Keats et al., 2018). We do not know enough about Ghanaian adolescent dietary patterns and the individual and environmental factors that influence their food choices. This information is vital to addressing the challenges adolescent girls face to getting a nutrient- and iron-rich diet in Ghana.

Adolescent food choices and eating habits are influenced by individual-level factors, including nutrition knowledge and skills, social determinants of health, and factors within their food environments (Neufeld et al., 2021). The Ottawa Charter for Health Promotion underscores the need to change both individual behaviour and social determinants of health to catalyze and sustain behaviour change - concurrently highlighting the key concept of health literacy (World Health Organization, 1986). The World Health Organization defines health literacy as "the achievement of a level of knowledge, personal skills, and confidence to take action to improve personal and community health by changing personal lifestyles and living conditions" (Nutbeam & Kickbusch, 1998). Low health literacy is linked to poor health status and reduced health and nutrition-promoting behaviour among adolescents (Carbone & Gibbs, 2013). Similarly, poor

nutrition-related health literacy has been associated with poor food habits and low diet quality in adolescents (Carbone & Gibbs, 2013; Joulaei et al., 2018; Kalkan, 2019; Koca & Arkan, 2021; Smith, 2009; Taleb & Itani, 2021; Vaitkeviciute et al., 2015).

The construct of health and nutrition literacy are composed of three domains – functional, interactive, and critical literacy (Guttersrud & Petterson, 2015; Nutbeam, 2000; Velardo, 2015). Functional nutrition literacy (FNL) is comprised of the basic reading and writing skills necessary to understand and apply nutrition information. Interactive nutrition literacy (INL) refers to the cognitive and interpersonal skills needed to seek and apply nutrition information to new scenarios and changing circumstances. Critical nutrition literacy (CNL) describes advanced social and cognitive skills to critically appraise and apply nutrition information to alter both personal lifestyle and the environment. The definition of CNL suggests that it reflects on both personal and environmental dimensions. Despite its theoretical promise, there is a lack of research on evidence-based interventions that improve CNL.

Figure 1.1 is a proposed framework for the pathways by which CNL may influence behaviour. Based on its definition, enhanced CNL would be manifested in two overarching behaviours – 1) the adoption of positive nutrition behaviour and practices, and 2) increased engagement in social action to alter social determinants of health. This conceptual framework helps to expose knowledge gaps and to provide the underpinning for this dissertation. Some of the research gaps this dissertation will address within the field of nutrition literacy research are 1) the lack of evidence-based interventions that enhance CNL among adolescents and 2) lack of

research on the influence of intervention models on both CNL-related personal behaviour and engagement in social action.

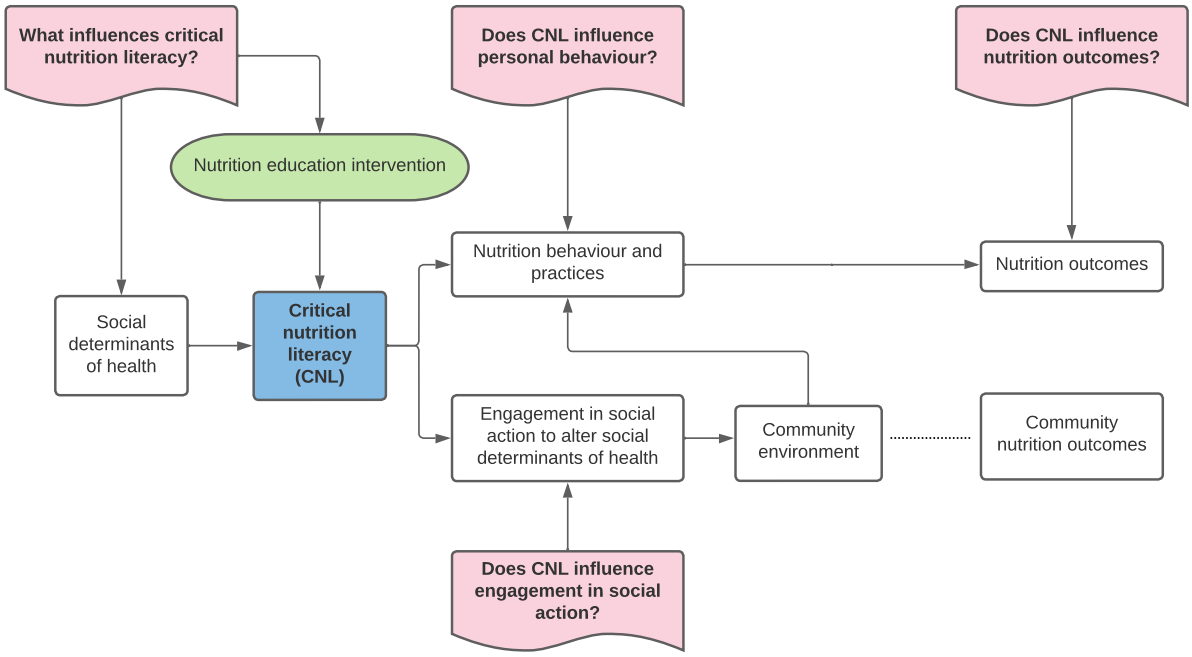

Figure 1.1 – Proposed critical nutrition literacy framework

Statement of purpose

This doctoral research aimed to test novel approaches to nutrition education that may enhance the capabilities inherent in CNL. Participatory video (PV) methods have been used since the 1960s in community development to foster dialogue, educate, research, and advocate for change (Harris, 2009; Lunch & Lunch, 2006; Roberts & Muñiz, 2018). Participatory video methods have only been used systematically in nutrition promotion by the Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) project since 2012 (Granger et al., 2018). Published studies focused on cultural acceptability and effectiveness of information uptake and personal behaviour change when nutrition-sensitive information was shared through a

PV medium. Studies have yet to explore the untapped potential of the video-making process on the thoughts, capacities, and behaviours of those who produced the videos. This doctoral research aimed to address this research gap. It evaluated the effectiveness of participatory video-making on adolescent video creators' nutrition literacy, food knowledge, dietary behaviour and intake. In addition to receiving nutrition education instruction, intervention adolescents participated in a series of activities that were designed to build capacity in basic film production, discuss nutritional issues with their peers, identify the pressing obstacles to an optimal diet that they faced, devise solutions, and then to produce a dramatized educational video that they would screen to their classmates.

Research objectives and lines of inquiry

This dissertation aimed to evaluate the effectiveness of a participatory video intervention in improving CNL and its allied behaviours – to improve personal dietary behaviour and engage in social action to improve living conditions – among adolescent video creators. The design of this doctoral research hinges on the following lines of scientific inquiry:

- To assess the benefit of a participatory video education intervention on nutrition literacy and dietary behaviours of adolescent girls in rural Ghana (Manuscript 1)
- To explore the most pressing obstacles adolescent girls faced in getting a balanced diet and iron-rich foods in a rural district of Ghana (Manuscript 2)
- To identify the most significant changes of the intervention as identified and evaluated by intervention participants and local stakeholders (Manuscript 3)

CHAPTER II. Review of the Literature

Global trends suggest that iron deficiency anemia, undernutrition, stunting, overweight, and obesity are persistent issues among adolescents (Abarca-Gómez et al., 2017; Akseer et al., 2017). A paradigm shift is needed in adolescent nutrition research, policy, and programs to curtail this trend (Hargreaves et al., 2021). The United Nations has underscored the importance of working alongside adolescents to tackle these issues and influence programs that affect their lives (United Nations, 2018). This chapter provides a review of the literature and synthesizes empirical evidence to inform the design of a participatory intervention. This literature review explores the issue of adolescent malnutrition in Ghana in vulnerable adolescent populations, synthesizing data on Ghanaian food environments and dietary behaviours, and outlining pressing nutritional issues. This review describes the concept of CNL and critical pedagogy and explores how participatory video-making can be re-imagined as a nutrition education intervention to address adolescent malnutrition.

A vulnerable population

Adolescents have been overlooked in research in comparison to other age groups (Hargreaves et al., 2021). Nutrition statistics about adolescents have often been merged with children or adults. For example, national Demographic and Health Surveys often present aggregated data about adolescent girls with other women of reproductive age (WRA) that are 15-49 years of age (Ghana Statistical Service et al., 2015). Additionally, though nearly 90% of the world's 1.2 billion adolescents reside in LMICs, the majority of adolescent nutrition research has taken place in industrialized countries (Carducci et al., 2021; Neufeld et al., 2021; United Nations et al., 2017). Around 20% of the world's youth reside in sub-Saharan Africa (SSA) and by 2030 that

number will steadily rise to 42% (United Nations et al., 2017). A systematic review of research on adolescent food consumption highlights the lack of quantitative national data in Sub-Saharan Africa from 2010-2020 (Figure 2.1) (Neufeld et al., 2021). The paucity of data for adolescent diet in Sub-Saharan Africa poses a challenge in understanding the unique challenges, drivers, and influencers of adolescent nutrition in these environments.

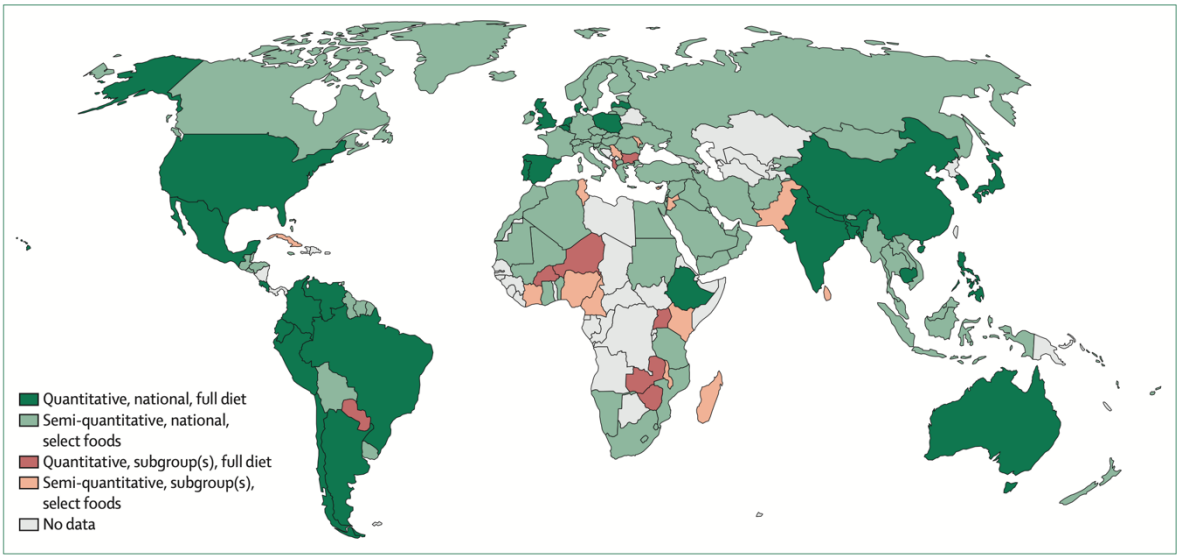

Figure 2.1 – Map of available information on adolescent dietary intake from 2010-2020 (Neufeld et al., 2021)

Adolescent malnutrition in developing and LMICs is a persistent problem (Kyu et al., 2016). Adolescents in LMICs are more likely to die from malnutrition (38.5 deaths per 100,000 children and adolescents) compared to those in high-income countries (0.2 per 100,000). (Kyu et al., 2016) Adolescent girls in LMICs experience elevated risk of malnutrition – micronutrient deficiencies, underweight, overweight, and obesity (Akseer et al., 2017) and adolescent girls have a more pronounced inadequacy in vitamin and mineral intake (Das et al., 2017). For example, the prevalence of iron deficiency and IDA is higher among adolescent girls than their male counterparts and higher within countries with a lower social development index (Figure

2.2) (Christian & Smith, 2018). Adolescent girls are biologically predisposed to particular health risks such as IDA due to menstrual blood loss (de Andrade Cairo et al., 2014). Additionally, there are gender-related discrepancies in the social determinants of health that increase girls' health risks (Sen et al., 2007). Sociocultural norms about appropriate gender behaviour can influence what is viewed as preferable dietary choices, the distribution of iron-rich and/or animal-sourced foods within a household, and the appropriate use of health services (Sen et al., 2007). These often-subtle influences of social and gender norms give rise to patterns of disproportionate ill-health, and nutritional status (Belachew et al., 2011; Darling et al., 2020; Spitzer, 2005). A longitudinal study in India described pro-boy gender differences in dietary behaviours where adolescent boys had a more diverse diet and consumed more protein- and vitamin-rich foods such as eggs, legumes, root vegetables, and fruit (Aurino, 2017). The gender gap in diet was not associated with maternal education, poverty, or place of residence. Caregivers' desire for their male adolescent to graduate secondary school was associated with the pro-boy gap at 15 years old. This suggests that parental attitudes towards gender can influence gender gaps in adolescent diets. A cross-sectional study from Burkina Faso, Ethiopia, Ghana, Nigeria, Tanzania, and Uganda provided further evidence that gender is a key predictor of nutritional status among adolescents (Darling et al., 2020). Female participants, 10-19 years of age, were less likely to be underweight (pooled prevalence ratio (PR) 0.66, 95% CI 0.57, 0.77) or stunted (pooled PR 0.63, 95% CI 0.55, 0.71) compared to male participants. However, girls were at a higher risk of being overweight (pooled PR 1.60, 95% CI 1.26, 2.06) and were less likely to be physically active for more than 1 hour a day (pooled PR 0.77, 95% CI 0.67, 0.88). A systematic review in Sub-Saharan Africa reported gender differences in body composition, where 31 studies reported that girls had larger body composition than boys versus five studies

where boys reported being larger (Muthuri et al., 2014). The review suggested that the differences in body composition were attributed to gender roles where boys were encouraged to participate in more physical activity than girls. Understanding the social and environmental factors that influence and disadvantage adolescent girls' diets may inform gender-based nutrition interventions.

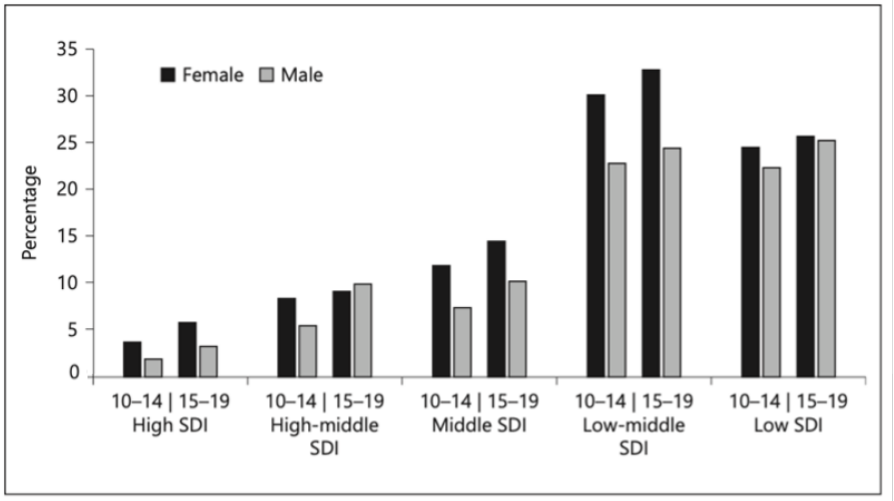

Figure 2.2 – Estimated global prevalence of iron deficiency anemia, stratified by age, sex, and Social Development Index (modified) (Christian & Smith, 2018)

Evidence suggests that rural adolescents experience social and health inequities in comparison to their urban counterparts. The 2017-18 national Multiple Indicator Cluster Survey Six results show that rural Ghanaian adolescents had lower literacy rates and higher rates of teen pregnancy and child marriage compared to their urban counterparts (GSS et al., 2018). Rural school-aged children and adolescents, 7-14 years of age, were outperformed by their urban counterparts in both basic reading and numeracy skills. Only 12% of rural adolescents had basic reading skills to read 90% of words in a story correctly and answer comprehension questions versus 32% of urban adolescents. Only 8% of rural adolescents could successfully perform number reading and discrimination tasks, addition task and pattern recognition tests compared to

16% among their urban counterparts. Adolescent pregnancy increases nutritional needs and elevates the risk of adolescent micronutrient deficiencies. There were 98 births per 1000 rural girls, 15-19 years of age, as compared to 50 births per 1000 urban girls 15-19 years of age. Additionally, 27% of rural girls were married by 18 years, versus 13% of urban girls. Finally, household data showed that only 68% of rural adolescents had access to clean water, as compared to 93% of urban adolescents. There were also differences in exposure to health risk factors, lifestyle, and dietary behaviour between urban and rural settings (Eberhardt & Pamuk, 2004). Rural dwelling has been associated to increased prevalence of anemia (Agyei-Frempong et al., 2001; Ayensu et al., 2020).

Intersectionality describes how marginalized individuals or groups experience the cumulative effects of multiple forms of discrimination such as ageism, sexism, and classism (Crenshaw, 1989). It provides a conceptual framework to understand these forms of discrimination and their influence on health inequities in a population (Kapilashrami & Hankivsky, 2018). Evidence suggests that rural adolescent girls in LMICs are at a crossroads of multiple social inequities and are disproportionately burdened by risk factors that may contribute to poor nutrition.

Iron deficiency anemia

Anemia is a persistent public health problem across the globe, though its prevalence is disproportionately high in developing countries (Balarajan et al., 2011; Miller, 2013; Turawa et al., 2021). The prevalence of anemia was 9% in industrialized countries versus 43% in developing countries - where Africa and Asia accounted for more than 85% of the absolute burden of anemia among high-risk populations (Balarajan et al., 2011; Mclean et al., 2009). A repeated cross-sectional analysis of Demographic Health Surveys of 45 LMICs from 2000-2014

shows that anemia remains a significant issue among non-pregnant girls, 15-19 years of age (Yang et al., 2018). More than 20% of non-pregnant girls in 37 of the 45 LMICs were anemic in 2014 and anemia was more prevalent among girls with low socio-economic status.

There are multiple causes of anemia including micronutrient deficiencies, blood loss, and chronic infections such as hookworm and malaria (Gautam et al., 2019; Miller, 2013; Tandoh et al., 2021; Wegmüller et al., 2020). Anemia's etiology is complex and varies across populations. This presents a public health challenge to find effective means to address the root causes of the disorder (Balarajan et al., 2011)

Nutritional anemia often results from the inadequate intake of micronutrients needed for blood formation such as iron, folate, riboflavin, vitamins A, B12, and C (Miller, 2013). Iron deficiency is a precursor to IDA and accounts for approximately 50% of all cases of anemia in WRA (Stevens et al., 2013; Turawa et al., 2021). Iron deficiency is also the most common nutritional deficiency among adolescents (Kyu et al., 2016). Increased iron is needed to sustain rapid adolescent growth, particularly in lean body mass, blood volume, and red cell mass (Cusick & Kuch, 2012). This rapid growth exerts a large toll on iron stores, making adolescents susceptible to iron deficiency. The high demand of iron for growth (15 milligrams per day for girls, 14-18y), blood loss during menstruation, and the increased prevalence of hookworm infections in developing countries put adolescent girls in LMICs at elevated risk for this deficiency (Corkins et al., 2016; Kyu et al., 2016).

The consequences of anemia and IDA on morbidity include cognitive impairment and increased susceptibility to infection (Balarajan et al., 2011) as well as poor academic performance and productivity among adolescents (Mengistu et al., 2019). Iron deficiency and IDA contributed to the majority of disability-adjusted life years (DALYs) among micronutrient

deficiencies in adolescent girls (>2,500 DALYs per 100,000 adolescents) (Akseer et al., 2017; Christian & Smith, 2018). Africa and parts of Asia bear 65% of the global burden of DALYs lost, whereas North America bears only 1.4% of the global burden (Stoltzfus, 2003). There is an urgent need to develop effective and sustainable interventions to prevent IDA in vulnerable populations.

Adolescent malnutrition in Ghana

Ghana is experiencing high rates of iron deficiency anemia. The 2017 Ghana Micronutrient Survey estimated that 26.4% of non-pregnant adolescent girls, 15 to 19 years of age, were anemic (hemoglobin < 120 g/L) (University of Ghana et al., 2017). In the same study, 20.9% of the girls had iron deficiency (serum ferritin < 15.0 µg/l), and 14.5% had IDA (hemoglobin < 120 g/L and serum ferritin < 15.0µg/L). This may be an underestimation. The 2014 Ghana Demographic and Health Survey suggested the number is quite higher, reporting that 48% of adolescent girls aged 15-19 years were anemic (Ghana Statistical Service et al., 2015). A recent cross-sectional study published in 2021 in the Ahafo region determined that 50.3% of adolescent female students were anemic (Tandoh et al., 2021). These statistics signal a national public health concern. There is inconsistent and insufficient data about Ghanaian adolescent nutrition and IDA necessary to adequately shape adolescent nutrition programs and policies

Ghana Nutrition Policy

Ghana's National Nutrition Policy Report 2013-17 acknowledged anemia as a national public health concern (Ministry of Health and the Ghana Health Service, 2013, 2016). The report did not make specific reference to statistics about adolescent girls. However, it did highlight the troubling increase in anemia among non-pregnant WRA, 15-49 years of age, from 2003 to 2008 and proposed solutions. There were two specific policy measures that were proposed. The first

included the distribution of weekly iron supplementation. The World Health Organization recommends iron and folate supplementation to prevent and treat anemia in all menstruating women in countries with high rates of anemia (World Health Organization, 2016). Ghana initiated its Girls' Iron-Folate Tablet Supplementation (GIFTS) Programme in 2017 which provided adolescent girls with weekly iron and folic acid supplementation tablets. A 2017-18 impact evaluation of the GIFTS program was conducted among 60 schools in the Northern and Volta regions of Ghana (Ghana Health Service et al., 2019). Out of the 1551 adolescents that completed both baseline and endline surveys, 75% received 10 or more weekly iron-folate supplements and 46% reported receiving any health or nutrition education during the previous academic year. Evidence showed a 26% decreased in population prevalence of anemia after adjusting for student age. Though iron supplementation was an effective tool in reducing the prevalence of IDA, it does not address the underlying dietary behaviours and environmental factors that underpin iron deficiency (Ghana Health Service et al., 2019; Lassi et al., 2017). Additionally, iron supplementation alone has not been sufficient to address high rates of anemia in Ghana in the past. For example, Ghana has implemented iron and folic acid supplementation for pregnant women in accordance with 2001 World Health Organization recommendations (60 mg iron and 400μg folic acid) (Ampiah et al., 2019). Rates of anemia remain high in this demographic, suggesting a more comprehensive strategy is needed. The 2010 Ashanti Health report described how, despite the implementation of iron supplementation, anemia was the second leading cause of death in the Ashanti region among pregnant women (Ampiah et al., 2019).

The second policy measure included developing behaviour change communication about diversifying diets and supporting healthy food choices (Ministry of Health and the Ghana Health

Service, 2013, 2016) Since the policy report's release, there has been no reference to the implementation or evaluation of the proposed behaviour change communication strategy. In general, Ghana Health Service promotes the application of the *Go, Grow, Glow* principle to get a balanced diet. This implies that a meal would include all three of the following food groupings: 1) energy-giving "Go" food (fats, oils, and starchy food), 2) body-building "Grow" food (animal-sourced food, beans, and nuts), and 3) protective "Glow" food (fruits and vegetables) (Nutrition Department Ghana Health Service, 2009). They also promote an iron-rich diet to avoid IDA through local animal-sourced foods, iron-rich plants, and dark green leafy vegetables consumed with vitamin C-rich fruits (Nutrition Department Ghana Health Service, 2009). A 2020 study showed that there were ample locally sourced dark green leafy vegetables that would help adolescent girls acquire their recommended daily iron intake (Callister et al., 2020). The study analyzed the correlation between common food groups in a Ghanaian diet and hemoglobin levels. Results confirmed that iron from animal foods ($\beta = 0.016$, $p < 0.01$) and plant sources ($\beta = 0.013$, $p < 0.01$) influenced hemoglobin levels (Callister et al., 2020). This supports efforts to promote the consumption of animal foods and iron-rich plants and plant protein to prevent IDA in Ghana. Since iron-rich leafy vegetables like kontomire (*Xanthosoma sagittifolium*), alefu (*Amaranth cruentus*), ayoyo (*Corchorus olitorius*) are readily available, accessible, and affordable, its promotion may be more readily adopted into Ghanaian diets (Callister et al., 2020).

Little is known about the actual dietary patterns of Ghanaian adolescents and their food environments. Though research on adolescent diet is limited, there are various studies that can help to outline general dietary patterns across Ghana.

A Ghanaian diet

Ghana is experiencing a nutrition transition. This includes changing food systems and food availability that influence a population's dietary patterns and nutrient intake (Campbell et al., 2017; Rousham et al., 2020). There have been significant shifts in food availability and consumption in Ghana from 1983 to 2013. Sub-national studies described the increased availability of processed foods and a limited supply of fruits and vegetables (Dake et al., 2016; Kushitor, 2021). For example, there was a 1075% increase in the availability of sugar and sweeteners from 1983 to 2013 (Kushitor, 2021). This has been associated with Ghana's high consumption of processed sugar-sweetened beverages (Frederick & Obed, 2017) and low consumption of fruits and vegetables (Amo-Adjei & Kumi-Kyereme, 2015). The increase in the availability of rice, sugars, and tubers has changed dietary patterns, resulting in low dietary diversity and high energy intake (Kushitor, 2021). Carbohydrate-rich foods like rice and tubers provide the highest contribution to daily energy intake, (Kushitor, 2021) where starchy tubers make up to three-quarters of dietary energy (Rousham et al., 2020). A cross-sectional study that looked at dietary patterns in rural and urban Ghana had shown that carbohydrate-rich foods are more readily consumed in rural areas than urban areas (Galbete et al., 2017). Their diet was also rich in nuts, seeds, plantains, corn, legumes, and palm oil (Galbete et al., 2017). A study with rural mothers described that over 95% of study participants consumed fish at least once a week, while 95% of individuals consumed other animal-sourced food like poultry less than once a month (Nti, 2008). Over 75% of participants consumed non-heme sources of iron at least once a week. An analysis of the 2008 Ghana Demographic and Health Survey revealed how only 5.4% and 2.5% of non-pregnant WRA consumed at least five servings of fruit and vegetables a day, respectively (Ghose & Yaya, 2018). Those who did not consume at least five fruits and

vegetables a day had a significantly higher likelihood of being anemic. Results from a 2018 cross-sectional study in the Binduri district revealed how 71.2% of non-pregnant WRA had low diet diversity (less than 4 out of 7 food groups) and that dietary diversity scores were a strong predictor of hemoglobin concentrations (Ayamba, 2018). This suggests that interventions that promote diversified diets rich in fruits and vegetables may be an effective strategy for reducing the risk of anemia among Ghanaian WRA. It is important to understand Ghanaian dietary patterns and its components to promote culturally acceptable dietary habits that can prevent IDA.

The dietary patterns of Ghanaian adolescent girls are currently understudied. A study among 2948 female Ghanaian students, 10-19 years of age, described how 19.2% consumed rich sources of heme-iron such as red meat and organ meats in the previous day (Gosdin et al., 2020). In contrast, 68.5% of research participants consumed fair sources of heme-iron such as white meats, eggs, and fish, and 68.3% consumed sources of non-heme iron such as dark-green leafy vegetables, legumes, and seeds in the previous day. A cross-sectional study with 270 girls, 10-19 years of age, from four communities in the Lower Manya Krobo district, showed a high consumption of energy-dense nutrient-poor food (Osei Owusu, 2017). The results of the food frequency questionnaire described how 63.3% of participants consumed cereals daily and 45.2% ate sweets daily. Only 10.0% and 8.1% of the girls consumed fruits and vegetables daily. Though 37% of the girls ate fish daily, only 6.7% ate other forms of meat every day. Additionally, 81.9% of adolescents described eating out of the home every day. Another study showed that junior high school students in Ghana preferred high sugar and fat content food products (Atsreh Buxton, 2014). This is consistent with the results of a systematic review that reported high consumption of energy-dense nutrient-poor foods and low dietary intake of meats, fruits, and

vegetables among adolescent girls in low- and middle-income countries (Atsreh Buxton, 2014; Keats et al., 2018).

Adolescent food environments and food choice

Adolescent food choices and eating habits are shaped by factors within food environments, social determinants of health as well as personal factors including nutrition knowledge and skills (Neufeld et al., 2021). Adolescents' dietary intake occurs within different food environments (home, school, and markets) where they interact with food systems to obtain, prepare, and consume food (HLPE, 2017). Food environments are made up of physical, economic, and socio-cultural factors that play a role in informing food choices and shaping dietary patterns (HLPE, 2017). Although conceptual frameworks have been proposed to explore the influence of food environments on dietary patterns, they rarely include adolescents (Carducci et al., 2021; Hawkes et al., 2020; Raza et al., 2020). There have been recent advances in this field with the development of *The Innocenti Framework for Food Systems and Children's and Adolescents' Diets.* This framework has helped to conceptualize the relationship among different food system drivers (e.g., socio-cultural), determinants (e.g., caregiver and adolescent behaviors), and their influencers (e.g., intra-household dynamics) on adolescent diet (Figure 2.3) (UNICEF & GAIN, 2019). This framework is based on current literature around adolescent food environments that was primarily conducted in high-income and upper-middle-income countries. Though adolescents from LMICs make up the great majority of the world's adolescent population, very few studies have considered adolescents from LMICs (Carducci et al., 2021).

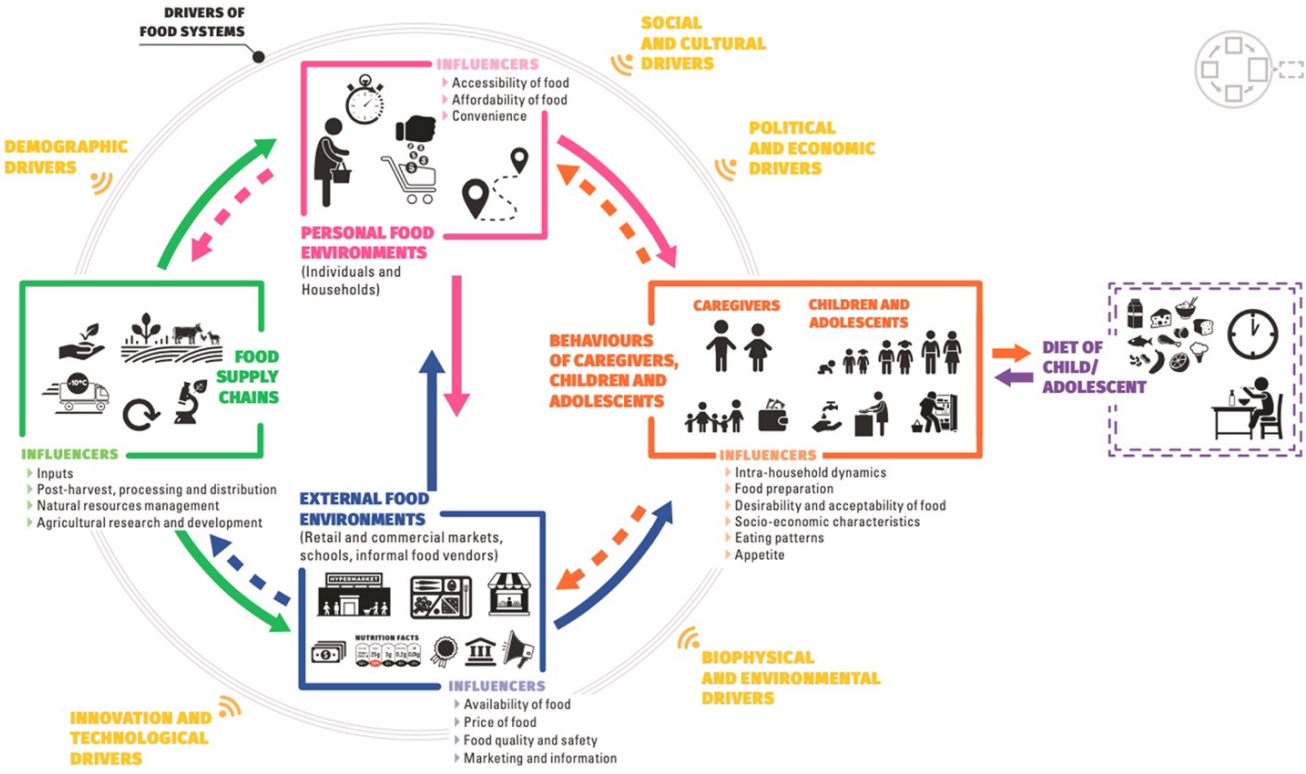

Figure 2.3 – The Innocenti Framework for food systems and children's and adolescents' diets (UNICEF & GAIN, 2019)

Personal factors such as food knowledge and skills help shape eating habits. Nutrition education interventions traditionally rely on health behaviour theories that focus on influencing individual-level factors that promote behaviour change and disregard underlying environmental factors that may influence behaviour (Mogford et al., 2011). Nutrition education interventions that address individual-level factors are often successful in expanding nutritional knowledge yet have difficulty to sustain change in adolescent dietary behaviour (Contento et al., 1995; Joulaei et al., 2018) (Joulaei, 2018; Contento, 1995). What may be needed is to develop nutrition education models that develop higher cognitive and behavioural skills needed to promote and maintain healthy eating habits. Enhancing health and nutrition literacy, which includes the

knowledge, skills, and confidence to improve personal lifestyles and living conditions may have the potential to improve adolescent food choices and dietary behaviours.

Health and nutrition literacy

The World Health Organization defines health literacy as "the achievement of a level of knowledge, personal skills, and confidence to take action to improve personal and community health by changing personal lifestyles and living conditions. Thus, health literacy means more than being able to read pamphlets and make appointments. By improving people's access to health information, and their capacity to use it effectively, health literacy is critical to empowerment." (Nutbeam & Kickbusch, 1998). Health literacy has become a prioritized intervention outcome for those interested in health education and promotion as evidence builds about its influence on health behaviour and outcome. Low health literacy is linked to poor health status and reduced health and nutrition-promoting behaviour among adolescents (Carbone & Gibbs, 2013). Similarly, poor nutrition-related health literacy has been associated with poor food habits and low diet quality in adolescents (Carbone & Gibbs, 2013; Joulaei et al., 2018; Kalkan, 2019; Koca & Arkan, 2021; Smith, 2009; Taleb & Itani, 2021; Vaitkeviciute et al., 2015). The WHO acknowledges that improving health literacy, particularly in marginalized and disadvantaged communities, will catalyze progress towards meeting the goals set for the 2030 Agenda for Sustainable Development. They clarify that improving health literacy "provides the foundation on which citizens are enabled to play an active role in improving their own health, engage successfully with community action for health, and push governments to meet their responsibilities in addressing health and health equity" (World Health Organization, 2022).

Nutrition literacy has not been as heavily researched. The term nutrition literacy is fairly new and there is no consensus on a standard definition (Carbone & Gibbs, 2013). One prominent

definition is that nutrition literacy is related to the capacity to access, understand, and apply nutrition information to improve nutrition outcomes (Velardo, 2015; Vettori et al., 2019). Since there is no standard definition, there also is no standardized list of indicators to monitor or measure the change in nutrition literacy (McCormack, 2010). Similar to Nutbeam's definition of health literacy, the construct of nutrition literacy has been described as having three domains – functional, interactive, and critical nutrition literacy (Guttersrud & Petterson, 2015; Nutbeam, 2008). Functional nutrition literacy (FNL) is comprised of the basic reading and writing skills necessary to understand and apply nutrition information. Interactive nutrition literacy (INL) refers to the cognitive and interpersonal skills necessary to seek and apply nutrition information to new scenarios and changing circumstances. Critical nutrition literacy (CNL) reflects the social and cognitive skills to critically appraise and apply nutrition information to alter both personal lifestyle and environment factors (Guttersrud & Petterson, 2015; Nutbeam, 2000). At this highest degree of nutrition literacy, CNL, individuals appreciate that their nutrition outcomes are intimately linked to their environment. For example, environmental factors can influence what food is available, accessible, or culturally acceptable. Similarly, one would appreciate that they too can influence the socio-cultural and physical environment around them. According to the proposed model in Figure 1.1 *(presented in the introduction),* CNL is manifested in two main ways – changes in personal lifestyle and increased engagement in social action to promote change in community health.

The promotion of CNL has seldom been investigated. Most studies that evaluate nutrition literacy interventions present aggregated data on nutrition literacy, rather than disaggregating the data by domain. This makes it difficult to understand an intervention's influence on FNL, INL, and CNL. One study has published data exploring the influence of education intervention on

CNL. It included a non-experimental pre-post study of a 13-week academic nutrition course (lectures and hands-on labs) with American college students that led to an increase in CNL scores (2.34 ± 0.7 to 2.63 ± 0.7; $p<0.01$) (Bedoyan et al., 2019). The assessment tool used in Bedoyan et al.'s study focused on measuring the capacity to critically analyse and appraise nutrition information which differs from other tools used (Bari, 2012; Bedoyan, 2019; Doustmohammadian et al., 2017). There is a clear research gap in the development and evaluation of interventions that may influence CNL.

Critical pedagogy

Education approaches that build on Freire's work on critical consciousness may be useful for CNL interventions. Freire posited that critical consciousness, like CNL, is related to the capacity to analyze how social environments may limit well-being and to take action to change perceived challenges (Freire, 1970). Freire reimagined educational approaches to enhance critical consciousness - suggesting programs should invite participation, dialogue, critical analysis, and learning in action (Freire, 1970, 1974). This involves group dialogue to identify issues and its underlying causes, devise a strategy to overcome the issues, and envision the implementation of the solution. This allows for participants to think critically and generate new perspectives and social knowledge. Most importantly, these conversations are grounded in action in order to reinforce the assumption that participants are protagonists in their own lives. Finally, Freire suggested that reflection is needed after group dialogue and action. Wallerstein and Berstein argued that education for critical consciousness needs to consider the relationship between the individual and their environment and community (Wallerstein & Bernstein, 1988). They suggest that community participation is needed to shift and develop new beliefs and efficacy to influence

both personal and community life. The targets of Freirean educational approaches are not just individuals, but to promote both group and structural community change.

Wallerstein and Bernstein extended Freirean pedagogy to health education and promotion. They outlined Freire's three-stage methodology for an empowering education program: 1) to listen and understand the issues prevalent in a community, 2) participatory dialogue to investigate the issues at hand, often through the use of the arts, and 3) envisioning and acting upon the changes promoted in the dialogue. Stage two involves creating "codes" that are concrete representations of the identified issue. This can be in the form of photographs, stories, and role-play. Freire suggested these codes represent the participants perceived reality and could serve as a tool for discussion and problem-posing. Freire's thoughts on critical pedagogy have influenced the field of education and participatory approaches to community development. Nevertheless, its application in nutrition education has not been subject to rigorous research.

Participatory video intervention

Community development programs have used participatory video (PV) interventions to foster dialogue, educate, research, and advocate for change. Freire's work on critical pedagogy is often referenced as inspiring the participatory video-making process. (Harris, 2009; Roberts & Muñiz, 2018) During participatory video-making, participants make short films about issues affecting their lives by identifying a topic of interest, developing the content, filming, and screening the video. (Lunch & Lunch, 2006) The underlying assumptions and approaches of PV methodology are similar to those of Freire to enhance critical consciousness in education (Roberts, 2018). The elements include: participants are treated as protagonists in their own learning, enhanced conscientization, self-reflection and agency, and learning in action (Freire, 1970; Freire, 1973).

Though PV has been practiced in community development since the 1960s, it has been regularly used in nutrition promotion by Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) since 2012 (Granger et al., 2018). Research on the use of PV as an approach for nutrition promotion is fairly new. Published studies focus on cultural acceptability and effectiveness of information uptake and personal behaviour change when nutrition-sensitive information is shared through a PV medium (Dougherty et al., 2016; Harou et al., 2017; Kadiyala et al., 2021). The vast majority of studies that have looked at the influence of participatory video on nutrition knowledge and behaviour have focused on video audiences rather than the video creators. Studies show that watching PVs increased knowledge, self-efficacy and behaviour changes related to handwashing and feeding practices (Dougherty et al., 2016; Harou et al., 2017). Two other studies showed the important role of participatory activities in amplifying the influence of PVs (Cai et al., 2015; Kadiyala et al., 2021), but none of these studies looked at the influence of the video-making process itself. Nutrition research has focused on the audience that watches the participatory videos rather than those who produced them.

Conclusion

Iron deficiency anemia is a prevalent problem among adolescent girls in rural Ghana. Adolescence presents a window of opportunity to develop the social and cognitive skills to make informed nutrition decisions and set eating habits that will benefit them throughout life. Educational interventions may benefit from addressing the underlying personal and environmental causes of adolescent malnutrition. Critical nutrition literacy implies a degree of confidence and capacity to critically understand and appraise nutrition information, to analyze the environmental conditions that impede healthy eating, and adjust personal lifestyle and environmental factors to promote change. There is a clear lack of empirical evidence evaluating

programs that influence CNL. Freire's thoughts on critical consciousness and critical pedagogy can provide a framework to build CNL. This study is based on the premise that the process of participatory video-making can embody the principles that Freire outlined and might provide a model for nutrition education that can enhance CNL among adolescents. There was no published research highlighting the impact of participating in the PV-making process on nutrition behaviour change, the focus of this study. Addressing this research gap by evaluating the influence of participatory video making process on video makers may provide empirical data about an evidence-based intervention that can influence CNL. Since CNL is manifested in increased engagement in social action, it would be important to evaluate the influence of the intervention on the lives of participants and the people and environment that surround them. This study evaluated a participatory video intervention to improve adolescent CNL about the primary nutritional issues they faced – getting a balanced diet and preventing iron deficiency anemia.

Most rural districts in Ghana are underserviced and recruitment of girls in nutrition programs are poor (Ampiah et al., 2019). One of the rural and underserviced areas in Ghana is the Upper Manya Krobo district where the proposed research will take place. Formative research has helped to reinforce our understanding of the pressing need to address the access and quality of nutritional information provided to adolescent girls in this rural district. When interviewing over 1400 adolescent girls, 9 to 13 years of age in rural Upper Manya Krobo district in 2014, only 10% of survey participants reported having accessed nutritional information during the previous twelve months. (Ghadirian, unpublished data) This suggests the need to consider rural areas to study food environments and implement prevention strategies.

Bridge I

The previous chapters described the state of adolescent nutrition and the need to address anemia and to promote a balanced diet among adolescent girls in Ghana. The 2013 Ghana National Nutrition Policy proposed an iron and folate supplementation program for adolescent girls to address these nutrition issues (Ministry of Health and the Ghana Health Service, 2013). The allocation of iron supplements does not address the underlying dietary behaviour that sustains iron-poor diets. Research is needed to identify interventions that can improve adolescents' capacity to make informed and motivated decisions about their nutrition. Critical nutrition literacy was introduced as a construct that incorporates a level of confidence and capacity to critically appraise nutrition information and to apply it to improve personal lifestyle and living conditions. There is a lack of research about interventions that improve CNL.

The following trial evaluated the effectiveness of a participatory video nutrition education intervention on CNL, as well as functional and interactive nutrition literacy, food knowledge, food choice, and dietary intake. The premise behind this trial is that the participatory video-making activities may help enhance CNL. It is presumed that participatory video-making activities develop capacities related to CNL because it provides opportunities for adolescents to reflect on the nutrition information they were taught and the challenges they face in applying that information in their daily lives. In so doing, it may develop CNL capacities to critically analyze nutrition information and better understand environmental factors that are conducive to healthy eating. It also provides them with a framework for action so they can make educational videos to promote change. These capacities of active reflection, a consciousness of environmental influences on adolescent diet, action, and advocating for social change, may be important to

CNL. The results of the following study will inform the design of educational approaches that seek to influence CNL among adolescents.

CHAPTER III.

Participatory video intervention increased critical nutrition literacy of Ghanaian adolescent girls: a cluster randomized controlled trial[1,2]

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To submit to The Journal of Nutrition

[1] Source of financial support: The Canadian Queen Elizabeth II Diamond Jubilee Scholarships (QES) is managed through a unique partnership of Universities Canada, Rideau Hall Foundation (RHF), Community Foundations of Canada (CFC), and Canadian universities. The QES-Advanced Scholars Program is made possible with financial support from International Development Research Centre (IDRC) and Social Sciences and Humanities Research Council (SSHRC).

[2] Conflict of interest and funding disclosure: Mona Z Ghadirian, Grace S Marquis, Naa D Dodoo, and Neil Andersson declare no conflicts of interest.

Abstract

Objective: To assess the effect of a participatory video intervention on adolescent girls' nutrition literacy and dietary behaviours.

Design: Cluster randomized control trial

Setting: Twenty school-based girls' clubs in Eastern region, Ghana

Participants: Adolescent girls, aged 13-16 years, participating in school-based girls' clubs (n=351)

Intervention: All girls clubs received a nutrition curriculum. Intervention schools also participated in two series of activities where adolescents identified and produced videos on the most pressing challenges to getting (i) a balanced diet and (ii) iron-rich foods.

Measures: The primary outcome was critical nutrition literacy (CNL) - the capability to analyze and apply nutrition information to change personal behaviours and environment. Secondary outcomes included interactive nutrition literacy (INL), functional nutrition literacy (FNL), food knowledge, food choices, and dietary intake.

Analysis: General linear mixed models with cluster-level random effects.

Results: Exposure to the intervention led to a 4-fold increase in CNL (AOR= 4.24; 95% CI: 2.02, 8.87), as well as INL (AOR= 5.52; 95% CI: 2.21, 13.78) and FNL (AOR=2.14; 95% CI: 1.05, 4.33), food knowledge, and food choices. There was no group difference in daily food group consumption.

Conclusion: Participatory video is a feasible, acceptable, and effective education approach to promote CNL.

Keywords: critical nutrition literacy, nutrition literacy, participatory video, adolescent girls, nutrition education, Ghana

Introduction

Adolescence is characterized by increased autonomy, responsibility, and opportunities to develop nutrition-related behaviours that can persist throughout life.(1, 2) Adolescence presents a window of opportunity to foster healthy eating habits, therefore, that can contribute to current physical and cognitive development as well as positive health outcomes in adulthood.(3) Food environment, social determinants of health as well as individual-level factors including nutrition knowledge and skills all influence adolescent food choices and eating habits.(4) Consequently, we need to consider both environmental and individual factors in promoting adolescent nutrition. Nutrition education initiatives have sought an in-depth understanding of the drivers of adolescent food choices and to alter adolescent eating habits with varied results – novel approaches are needed to identify and to act on these drivers.(5)

Nutrition education interventions traditionally rely on health behavior theories that focus on behavior change at the individual level.(6) Approaches typically provide nutrition information to promote healthy eating habits. Though successful in expanding nutritional knowledge, these programs are often insufficient in altering and sustaining adolescent eating habits.(7, 8) Such efforts ignore the underlying environmental factors that may influence behavior.(6) The Ottawa Charter for Health Promotion underscores the need to change both individual behavior and social determinants of health to catalyze and sustain behavior change -- concurrently highlighting the key concept of health literacy.(9) The World Health Organization defines health literacy as “the achievement of a level of knowledge, personal skills, and confidence to take action to improve personal and community health by changing personal lifestyles and living conditions”.(10)

Improving health literacy has become a prioritized intervention outcome for those interested in health education and promotion as evidence builds that those with higher levels of health literacy can better understand and apply information to improve health.(11) Health literacy is considered a better predictor of health outcomes than age, income, employment, and educational attainment.(12, 13) Low health literacy is linked to poor health status and reduced health and nutrition-promoting behavior among adolescents.(13) Similarly, poor nutrition-related health literacy has been associated with poor food habits and low diet quality in adolescents.(7, 13-18)

Nutrition literacy builds on the concept of health literacy. The construct has three domains – functional, interactive, and critical nutrition literacy (19-21) Functional nutrition literacy (FNL) is comprised of the basic reading and writing skills necessary to understand and apply nutrition information. Interactive nutrition literacy (INL) refers to the cognitive and interpersonal skills needed to seek and apply nutrition information to new scenarios and changing circumstances. Critical nutrition literacy (CNL) describes advanced social and cognitive skills to critically appraise and apply nutrition information to alter both personal lifestyle and the environment. The definition of CNL suggests that it reflects both personal and environmental/ contextual dimensions. Despite its theoretical promise, there is a lack of research on evidence-based interventions that improve CNL.

In Ghana, the prevalence of stunting and thinness has remained stagnant from 2003 to 2014 among adolescent girls (22), and over 25% of non-pregnant adolescent girls, 15-19 years of age, were anemic in 2017 – signaling a national public health concern.(23) We report here the effect of a participatory video intervention on adolescent nutrition literacy and dietary habits in a Ghanaian underserviced rural environment.

Methods

Educational approach

Education approaches that build on Freire's work on critical consciousness may be useful for CNL interventions. Freire posited that critical consciousness, like CNL, is related to the capacity to analyze how social environments may limit well-being and to take action to change perceived challenges.(24) Freire reimagined educational approaches to enhance critical consciousness - suggesting programs should invite participation, dialogue, critical analysis, and learning in action.(24, 25) Community development programs have used participatory video interventions to foster dialogue, educate, research, and advocate for change. These often reference Freire's work on critical pedagogy.(26, 27) During the video-making, participants make short films about issues affecting their lives by identifying a topic of interest, developing the content, filming, and screening the video.(28) This study is based on the premise that the process of participatory video-making can embody the principles that Freire outlined and might provide a model for nutrition education that can enhance CNL among adolescents.

Collaborators

This study involved the active participation and guidance of five local stakeholders who made up a Community Advisory Board. They included representatives from a financial institution, a school management committee, a religious institution, Ghana Health Service, and Ghana Education Service. The Community Advisory Board met with the lead researcher (MZG) monthly to monitor and refine the intervention and research methodology described below.

Trial design

An unmasked, cluster randomized controlled trial was conducted from December 2018 to August 2019 to assess the effectiveness of a participatory video intervention on CNL and dietary

behavior of adolescent girls in rural Ghana. The clusters were schools; they were eligible to participate if they (i) had junior high school classes, (ii) hosted girls' clubs, and (iii) were within a 30-minute driving radius of the district capital, Asesewa. Twenty schools met the inclusion criteria. Eligibility criteria for participants were (i) female, (ii) 13 to 16 years of age, (iii) Krobo-speaking, and (iv) present in their girls' club on the day of enrollment. In these 20 participating schools, interested adolescent girls who met the inclusion criteria provided informed written assent and caregiver informed written consent to participate. McGill University's Research Ethics Board-III and the University of Ghana's Ethics Committee for the Humanities granted ethical clearance for the research to be conducted. The study was registered with clinicaltrials.gov (NCT03704649).

Sample

After determining the sampling frame of 20 schools, we stratified schools by presence of the Ghana School Feeding Programme. Six schools had the program and 14 schools did not. A stratified simple block randomization used blocks of two with a coin toss resulting in intervention first, control second, giving 10 intervention and 10 control schools. Random allocation sequence was based on a random number table generated by an individual outside of the research study.

Nutrition education curriculum for all schools

All 20 schools received a nutrition education curriculum about balanced diet and iron deficiency anemia for their girls' clubs. The lead researcher (MZG) and the Community Advisory Board chose the nutrition curriculum topics provided to all schools based on formative research on the state of nutrition of Ghanaian girls conducted in 2017 with community members, traditional leaders, and health and non-health staff at national and district levels (Ghadirian, unpublished

data). Using elements of established curricula from Ghana Education Services, World Vision Ghana, and Population Council (28, 29), the curriculum provided information and practical tools in three 60-minute lessons: adolescent nutrition, a balanced diet, and iron deficiency anemia. The lead researcher and two Community Advisory Board members trained the girls' club coordinators from both the intervention and control schools on how to facilitate the lessons. Project staff followed up with the coordinators, twice telephonically and once observing their lesson in person, to ensure they implemented all elements of the three lessons.

The lessons covered how to apply Ghana Health Service's *Go, Grow, Glow* principle to their meals to get a balanced diet with food from all three food groups: 1) energy-giving "Go" food (fats, oils, and starchy food), 2) body-building "Grow" food (animal-sourced food, beans, and nuts), and 3) protective "Glow" food (fruits and vegetables).(30) They also received tuition about iron-deficiency anemia and the importance of acquiring an iron-rich diet through local animal-sourced foods, iron-rich plants, and dark green leafy vegetables consumed with vitamin C-rich fruits.

Intervention

In addition to their regular girls' club sessions, the 10 intervention schools participated in a series of participatory video-making activities. During these activities, adolescents identified the most pressing challenge they faced to getting a balanced diet in their community and made a video about it. They repeated the process a second time to make a video about the challenges of preventing iron deficiency anemia. Each intervention school screened their two videos with their classmates and school staff. Project staff facilitated activities in the local language (Krobo). The activities adapted participatory video-making exercises designed by InsightShare.(31) The program helped the adolescents 1) develop basic skills in film production, 2) discuss with their

peers and identify the most pressing challenges to getting a balanced diet and preventing iron deficiency anemia, and 3) plan, act, and film two 10- to 12-minute educational videos on the two nutritional topics. Each video took around 12 hours over at least two days. After filming, participants met three more times to 1) watch their video, suggest edits, and to plan their video screening to their classmates, 2) screen and facilitate a discussion about the content of the video with their classmates, and 3) reflect as a group about any changes they might have seen after the video was screened.

Data collection

The participants answered a baseline survey (between December 2018 and February 2019) and an endline survey (between July and August 2019) in Krobo at their respective schools. The field staff carried out the surveys using tablets running the Open Data Kit software. The survey included socio-demographic information on adolescents' age, grade level, household assets, and parents' educational attainment. Participants' health literacy was assessed at baseline using the validated Rapid Estimate of Adolescent Literacy in Medicine Teen-S (REALM-Teen-S) instrument (32, 33). The REALM-Teen-S is an English word recognition test that measures an individual's ability to pronounce a series of health-related words. Word recognition tests are a standard way of assessing reading skills that results in a grade-level reading estimate.

The primary outcome was CNL. It was assessed at baseline and endline using an adapted 10-item questionnaire.(34, 35) Responses to the self-assessment statements were a five-point Likert scale from strongly disagree to strongly agree (e.g., "*On a scale from strongly disagree to strongly agree, how much do you agree with the following statement: I am willing to take an active role in measures aimed at promoting a healthier diet at my school*.")

We also measured secondary outcomes at baseline and endline. These included three other nutrition literacy indicators (food knowledge, FNL, and INL), food purchasing choices, and dietary intake. Food knowledge, FNL, and INL were measured using self-assessment statements that resulted in responses on a five-point Likert scale from strongly disagree to strongly agree.(34, 35) Food purchasing choices relied on a series of self-assessment statements that aligned with the promoted behaviors in the nutrition curriculum, such as *"I would like to know if you disagree or agree to these comments. When I buy myself a meal, I choose to eat iron-rich foods like beans, kontomire* (*Xanthosoma sagittifolium*), *and animal foods.",* with responses in a 5-point Likert scale from strongly disagree to strongly agree. A non-quantitative food frequency questionnaire determined frequency of food group consumption including animal-sourced food and local dark-green leafy vegetables.

Statistical methods

We provide descriptive analyses for key baseline characteristics and outcome variables and checked for group difference at baseline for the final model (Table 3.1). We categorised each response of the CNL questionnaire as a binary score (0=strongly disagree, disagree, or neutral; 1=agree, strongly agree) and tabulated a cumulative score for the 10 items (range 0 to 10). Using a simple majority as the threshold, we dichotomized the cumulative score (<6 = not critically nutrition literate; ≥ 6 = critically nutrition literate). An intention-to-treat (ITT) analysis assessed the impact of the intervention on CNL and secondary outcomes using a general linear mixed model (GLMM) with cluster as the random effect. The statistical analysis was done using CIETmap 2.2 open-source software which uses the statistical programming language R.

Sensitivity analysis

We reanalyzed unadjusted ITT estimates using two different cut-offs for the CNL measure – where the threshold for dichotomizing the cumulative score was set to 7 and then 8, (e.g. < 7 = not critically nutrition literate; ≥ 7 = critically nutrition literate). Since results were similar, we report only the analysis with a cut-off of 6 for CNL. Subgroup analysis determined if the intervention impact differed by baseline characteristics of the girls and their schools. Variables included adolescents' age, current educational attainment, health literacy reading grade-level, mother's educational attainment, household wealth as well as the schools' rurality.

Adjusted ITT effects added covariates to the GLMM, still using cluster as the random effect. Potential covariates included household wealth, mother's and father's educational attainment, adolescent's current educational attainment as well as baseline measures of FNL, INL, CNL, and health literacy. We also assessed variables with baseline differences between research arms. The saturated models included variables with a significant ($p<0.05$) unadjusted odds ratio. With stepwise deletion of the weakest association in each successive model, the final model retained only variables significant at $p<0.05$.

Results

A total of 351 adolescent girls, aged 14.4 ± 1.0 year, provided informed assent and caregiver consent to participate in the trial (Figure 3.1). No schools declined participation or were lost to follow-up; 10 intervention participants and 14 control participants did not complete endline surveys. Participants who were lost to follow-up were older than those who remained in the study (14.9 ± 0.7 vs 14.3 ± 1.0 y, respectively; $p=0.02$). There were no other baseline differences between those lost to follow-up and those who completed the study.

At baseline, 16% of the students (56/351) were enrolled in primary school (grades 4 to 6) and 84% (295/351) were enrolled in junior high school (levels 1 to 3). Based on their REALM-Teen-S assessment, the adolescents had a grade-4 average English reading level. The Upper Manya Krobo district was primarily rural and underserviced. Only 55% (194/351) of the participants reported having electricity, 27% (95/351) of participants' households owned a refrigerator, and only 13 adolescents reported having piped water in the home (13/351). Baseline characteristics were similar apart from the control group being wealthier than the intervention group, and the intervention group being more INL, and claiming better food choices than the control group (Table 3.1).

Primary outcome

Participants in the intervention schools showed a 4-fold increase in CNL with cluster taken into account as a random effect (unadjusted OR= 4.15; 95% CI: 1.95, 8.83).

Three potential predictor variables were significantly different between research arms at baseline (household wealth, INL, and food choices) and we tested these in the adjusted model. Being in junior high school was associated with an increased odds of CNL compared to being in primary school (OR= 2.51; 95% CI: 1.23, 5.09), being INL at baseline doubled the odds of CNL compared to those with low baseline INL (OR= 2.28; 95% CI: 1.18, 4.38), and CNL was also doubled among those who reported choosing iron-rich foods when purchasing meals for oneself at baseline (OR=1.96; 95% CI: 1.05,3.68).

The saturated multivariate model for CNL thus included treatment, wealth, current degree of school, baseline INL, and baseline food choice. Only two variables, current degree of schooling and baseline INL, retained significance in the adjusted model. In the multivariate model with these two variables, the intervention maintained its 4-fold effect (Table 3.2). Figure

3.2 depicts the change in CNL status from baseline to endline within the two research arms. Of intervention participants who were not CNL at baseline, 82% (69/84) increased their CNL by endline. Only 55% (45/82) of control participants had increased their CNL by endline. A sensitivity analysis that excluded the effect of clustering produced a similar odds ratio estimate (OR=3.78; 95% CI: 2.27, 6.30).

The intervention's effect on CNL was statistically significant in all sub-groups. There was a higher magnitude of effect on CNL among those who were in primary school (OR= 5.50; 95% CI 1.75, 17.33) or schools in rural settings outside the district capital (OR= 5.43; 95% CI 2.90, 10.16) as opposed to those in junior high school (OR= 3.78; 95% CI 2.10, 6.81) or schools in the district capital (OR= 2.97; 95% CI 1.13, 7.80). Adolescents whose mothers had attended junior high school (OR= 6.15; 95% CI 2.17, 17.44) experienced a greater magnitude of the intervention effect as opposed to those who had no formal education (OR= 3.81; 95% CI 1.29, 11.22) or attended primary school only (OR= 2.97; 95%CI 1.19, 7.46). Adolescents with low health literacy (below grade 6 reading level) did not respond differently to the intervention than those with high health literacy.

Secondary outcomes

Table 3.3 presents the estimated impact of the intervention on secondary outcomes.

ITT results indicated treatment group differences in food knowledge, FNL, INL, and food choices. At endline, intervention participants were seven times more likely to claim to know what Go, Grow, and Glow foods were and six times as likely to claim to understand the symptoms of iron deficiency and the foods needed to prevent it. There was no significant difference in dietary intake between research arms. There was, however, a difference in adolescent food choices when purchasing food for themselves. For example, exposure to the

intervention led to 12-fold increase in participants choosing iron-rich foods like beans, kontomire, and animal foods when buying a meal for themselves.

Discussion

This study is the first reported trial, that we are aware of, that investigated the influence of a participatory video intervention on nutrition literacy of adolescents. Participation in the intervention led to a large 4-fold increase in CNL and increases in food knowledge, FNL, INL, and changes in personal food choices.

Educators who find inspiration in Freire's critical pedagogy suggested that critical literacy could be enhanced through interactive, collaborative initiatives that also emphasize an understanding of the social determinants of health and critical analysis. (20, 36) The results from our study corroborate this claim. It provides evidence of the added value of a participatory model that engages adolescents in active collaborative learning on enhancing CNL. However, evidence suggests that the participatory nature of a nutrition education intervention alone does not guarantee success in changing nutrition-related knowledge and behaviour. In Zambia, a nutrition curriculum was provided to groups of adolescent girls within a participatory and interactive program. Despite the faithful implementation of the participatory program, they were unsuccessful in promoting food knowledge, dietary behavior, and nutrition outcomes. (37) They recognized the importance of identifying underlying diet-related challenges, and household and environmental factors that may influence adolescent diet – an element that was pivotal to our intervention. Only one other published study by Bedoyan et al. tested the effectiveness of a nutrition course on CNL. (38, 39) Their nutrition course included hands-on research labs where students could learn in action – a common element that was present in our intervention. They used a non-experimental pre-post design to show the positive influence of a 13-week academic

nutrition course (lectures and hands-on labs) on the CNL of American college nutrition students. They also concluded that nutrition education that enhances CNL should encourage students' capacity to analyze the credibility and application of nutrition information. Our research contributes valuable evidence of the application of critical pedagogy in nutrition. It opens the vista to the development of other examples of adolescent nutrition education initiatives that encourage collaborative learning, active reflection on social determinants of health and the application of nutrition information, and learning in action.

The concept of nutrition literacy is based on Nutbeam's hierarchical model of health literacy that is broken down into three degrees – functional, interactive, and critical. (40) It is assumed that functional nutrition literacy – manifested in basic reading skills and numeracy – sets a foundation for the cognitive and social skills necessary to develop interactive and critical literacy. This study suggests that the capacities related to FNL such as the ability to read and write may not be foundational to improving INL and CNL and suggests that a hierarchical model for nutrition literacy may need to be revised. Our findings show how higher degrees of nutrition literacy – interactive and critical – can be positively influenced in a demographic with poor functional nutrition literacy (91% of adolescents (319/351) were not functionally literate at baseline) and low literacy (adolescents had an average grade 4 reading level at baseline). This supports the premise made by Freire that there exist educational models that can enhance critical consciousness despite poor reading skills. (24) It also provides evidence to support the use of a participatory video intervention model to promote interactive and critical nutrition literacy among demographics that experience low literacy.

Enhanced nutrition literacy is associated with increased fruit and vegetable intake and improved diet quality among adolescents, (16, 18, 41-45) yet the promotion of CNL among

adolescents is seldom investigated. (38, 39) Our participatory video intervention was successful in enhancing CNL but did not have an influence on adolescents' dietary patterns. Further research is needed to better understand the environmental factors that influence adolescent girls' dietary intake. A study with other West African adolescent girls suggested that their home and school environments were not conducive to healthy eating due to high rates of household food insecurity and the lack of affordable healthy food options like animal-sourced foods in their school canteens. (46) Research shows that adolescent girls have limited decision-making power over what food was procured and consumed in the household. (47) A lack of decision-making power would prevent adolescents from exercising their capacity to make informed food choices. A majority of Ghanaian adolescents (55%) in a different study reported making their own decision when purchasing food at school as opposed to complying with parents' instructions or peers' influence. (48) Our study did show a change in adolescents' food choices and purchasing habits, where intervention participants reported being more prone to purchase iron-rich foods and a variety of food groups when making decisions for themselves. Further research is needed to better understand the limitations of adolescent girls decision-making power and how that may influence food choices and dietary patterns.

This study is limited by the tools used. A non-quantitative food frequency questionnaire was used to assess dietary patterns. A multiple-pass 24-hour food recall would have been a more sensitive dietary assessment tool that may have detected more subtle changes in dietary intake. In terms of food habits, this study was not designed to assess the accessibility of the food it sought to promote. There were limitations to the assessment of CNL as well. The instrument used to assess CNL was adapted from validated tools by Bari (2012) and Doustmohammadian et al. (2017) (34, 35). As both tools were developed and validated for urban youth, they were modified

to be relevant for adolescents in an underserviced, rural context. Further research should be done to develop and validate an assessment tool for rural adolescents. Additionally, current assessment tools define and measure CNL skills differently. For example, the Critical Nutrition Literacy Evaluation Scale developed by Naigaga et al. (2018) focuses on measuring an individual's capacity to critically appraise nutrition information, a skill that does not take precedence in other CNL assessment tools (49, 50). Differing approaches to measuring CNL makes it difficult to generalize our results to the broader field of CNL promotion. There is a need to standardize a definition and assessment tool.

Understanding how to improve adolescents' CNL may help leverage behaviour change interventions. This cluster randomized control trial offers evidence of a viable educational model as intervention participants experienced a 4-fold increase in CNL. This study suggests that a participatory video intervention also has the potential to increase food knowledge, improve functional and interactive nutrition literacy, and affect changes in food choices. This finding supports claims that CNL can be enhanced by programs that invite participation, dialogue, critical analysis, and learning in action. Further research on the connection between participatory interventions and the promotion of adolescent CNL may be fruitful as a result. Furthermore, increased intervention research to identify best practices in promoting CNL among adolescents is needed. Research is also needed to better understand the relationship between increased CNL and dietary intake as well as the environmental factors that might mediate their relationship. Finally, this study and its findings open up the potentialities of new avenues of meaningful intervention as well as research in adolescent CNL

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Figure legend

Figure 3.1 – Study participant flow diagram in a cluster randomized control trial evaluating the effectiveness of a participatory video nutrition education intervention among adolescent girls in rural Ghana

Figure 3.2 – Change in critical nutrition literacy (CNL) status between baseline to endline in a cluster randomized control trial of a participatory video intervention with adolescent girls, 13-16 years of age, in rural Ghana

Table legend

Table 3.1 – Baseline characteristics of adolescent participants of a cluster randomized control trial in the rural Upper Manya Krobo district, Ghana.

Table 3.2 – Summary of intention-to-treat results of participatory video intervention on adolescent creators' functional, interactive, and critical nutrition literacy

Table 3.3a – Summary of intention-to-treat results of participatory video intervention on adolescents' food knowledge, food purchasing choices, and daily food consumption of a balanced diet

Table 3.3b – Summary of intention-to-treat results of participatory video intervention on adolescents' food knowledge, food purchasing choices, daily food consumption of iron-rich foods

Figure 3.1 – Study participant flow diagram in a cluster randomized control trial evaluating the effectiveness of a participatory video nutrition education intervention among adolescent girls in rural Ghana

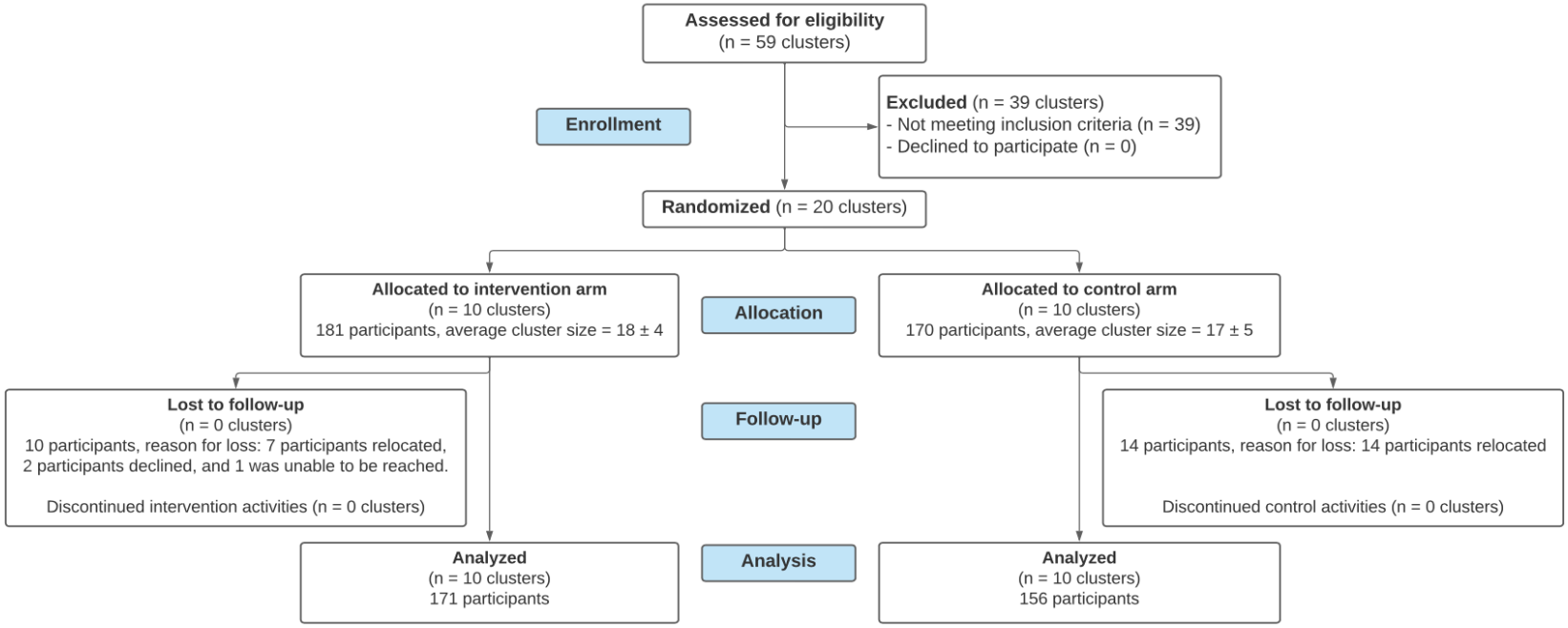

Figure 3.2 – Change in critical nutrition literacy (CNL) status between baseline to endline in a cluster randomized control trial of a participatory video intervention with adolescent girls, 13-16 years of age, in rural Ghana

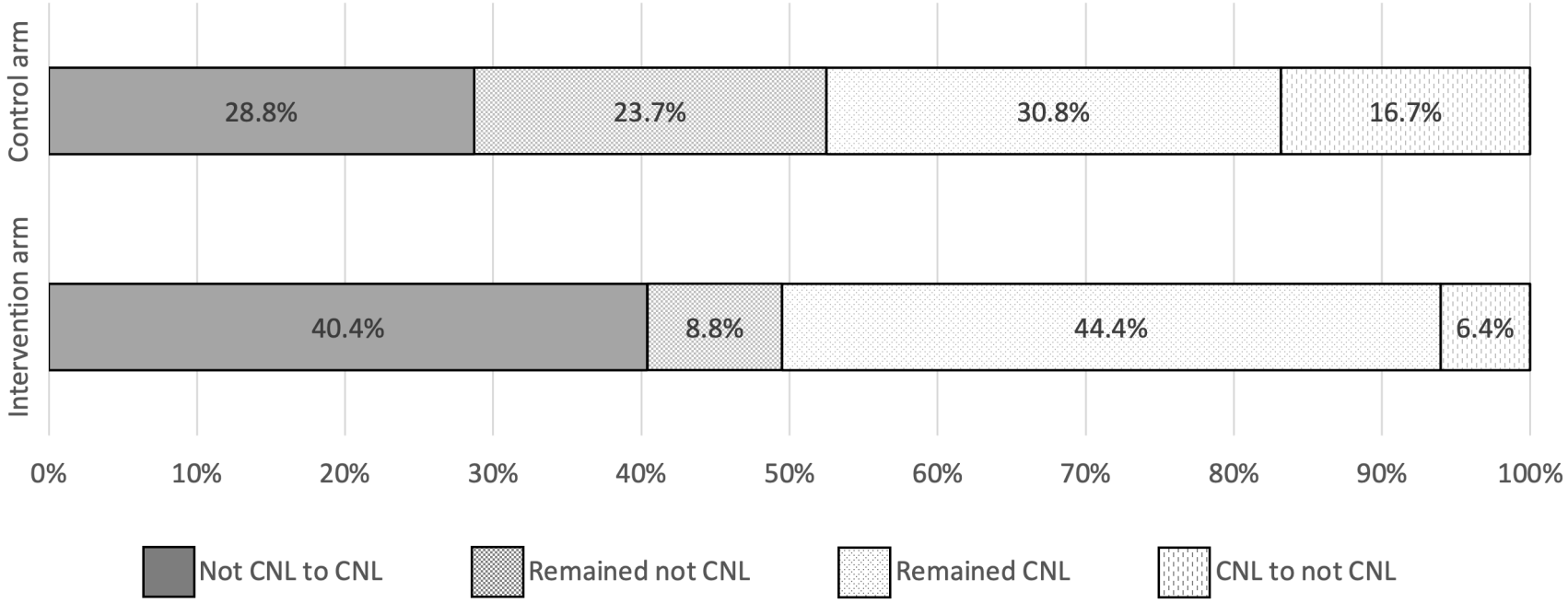

Table 3.1 – Baseline characteristics of adolescent participants of a cluster randomized control trial in the rural Upper Manya Krobo district, Ghana.

Characteristics	Intervention (n=181)	Control (n=170)	P-value[1]
Age (y)	14.3 ± 1.0	14.4 ± 1.0	0.20
Education, currently attending			
Primary school	30 (16.6)	26 (15.3)	0.11
Junior high school	151 (83.4)	144 (84.7)	
Health literacy – English reading grade level[2]			
3rd grade or below	84 (46.4)	74 (43.5)	0.66
4th-5th grade	37 (20.4)	40 (23.5)	
6th-7th grade	35 (19.3)	39 (22.9)	
8th-9th grade	22 (12.2)	14 (8.2)	
10th grade or higher	3 (1.7)	3 (1.8)	
Functional nutrition literacy[3]			
Functionally literate	15 (8.3)	17 (10.0)	0.31
Not functionally literate	166 (91.7)	153 (90.0)	
Interactive nutrition literacy[3]			
Interactively literate	61(33.7)	38 (22.4)	0.02
Not interactively literate	120 (66.3)	132 (77.6)	
Critical nutrition literacy[3]			
Critically literate	89 (49.2)	89 (52.4)	0.36
Not critically literate	92 (50.8)	81 (47.6)	
Food knowledge			
"I am familiar with Go, Grow, and Glow foods."	74 (40.9)	70 (41.2)	1.00

"I understand what food I need to eat to have good level of iron in my blood." *and* "I understand what can happen to my body when I don't get enough iron from the food I eat."	72 (39.8)	55 (32.4)	0.15
Food choice			
"I choose to eat food from all the food groups."	130 (59.4)	101 (71.8)	0.02
"I choose to eat iron rich foods like beans, kontomire and animal foods."	156 (86.7)	128 (75.3)	0.01
Average food group consumption (at least once / day)[4]			
Grow foods (of 7 groupings)	1.5 ± 1.0	1.6 ± 1.1	0.68
Glow foods (of 7 groupings)	2.6 ± 1.4	2.3 ± 1.4	0.05
Food group intake (at least once / day)			
Local iron-rich plants and vegetables[5]	34 (18.8)	21 (12.4)	0.10
Meat[6]	15 (8.3)	22 (12.9)	0.16
Fish[7]	146 (81.1)	47.9 (78.8)	0.59
Household wealth[8]			
Low	142 (78.5)	113 (66.5)	0.02
High	39 (21.5)	57 (33.5)	
Mother's education			
No formal schooling	43 (15.2)	29 (10.3)	0.65
Completed some primary school	50 (17.7)	45 (16.0)	
Completed some Junior high school or higher completed	63 (22.3)	52 (18.4)	

Values represent mean ± SD or n (%).

Cluster (school) was randomly assigned to intervention or control arm.

[1]Pearson $\chi 2$ tests were conducted for categorical variables and simple linear regression for continuous variables, values were statistically significant $p < 0.05$

[2]Health literacy is assessed using the validated REALM-Teen-S tool; an English word recognition test to assess an individual's ability to pronounce a series of health-related words. Results provide an estimate of reading grade-level.

[3]Functional, interactive, and critical nutrition literacy were measured using an adapted self-assessment questionnaire. Responses to series of self-assessment statements were provided per domain of nutrition literacy on a 5-point Likert scale from strongly disagree to strongly agree, then categorized into a binary score. A cumulative score was tabulated and was dichotomized using a predetermined threshold resulting in a binary score (0=not critically literate, 1=critically literate).

[4]Daily food group consumption was measured using a non-quantitative food frequency questionnaire and categorized in accordance with Ghana Health Service *Go, Grow, and Glow* dietary recommendations. (Nutrition Department Ghana Health Service, 2009) Grow food category: (1) organ meats, (2) meat such as beef, pork, lamb and goat, (3) poultry, (4) fish, shellfish, or other seafood, excluding powdered fish, (5) food made from legumes, beans, nuts, or seeds, (6) milk and milk products, and (7) eggs. Glow food category: (1) yellow or orange vegetables, (2) dark green leafy vegetables, (3) turkey berry (*Solanum torvum*), (4) okra, garden egg, or plantain, (5) tomatoes, (6) vitamin C-rich fruits, and (7) other fruits.

[5]Local iron-rich plants and vegetables include: dark green leafy vegetables such ask kontomire (*Xanthosoma sagittifolium*), aleefu (*Amaranth cruentus*), bokoboko *(Talinum triangulare)*, ayoyo (*Corchorus olitorius*), and turkey berry (*Solanum torvum*).

[6]Meat includes: beef, pork, lamb, goat, chicken, guinea fowl, and organ meats such as liver, kidney, heart, and gizzard.

[7]Fish includes: smoked, fried, dried, or cooked fish, shellfish, or other seafood, excluding powdered fish.

[8]Household wealth was measured as a summative score reflecting the possession of 13 assets – electricity, pipe-borne water, radio, fan, cupboard, television, bicycle, motorbike, refrigerator, car or truck, tractor, cattle, and goat or chicken – and then organized into tertiles: 1 to 2 assets, 3 to 5 assets, and 6 to 13 assets. Tertiles were later dichotomized: 1 to 5 assets reflected low household wealth relative to those with 6 to 13 assets (high household wealth).

Table 3.2 – Summary of intention-to-treat results of participatory video intervention on adolescent creators' functional, interactive, and critical nutrition literacy

	Functional Nutritional Literacy[1]		**Interactive Nutrition Literacy[2]**		**Critical Nutrition Literacy[3]**	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Treatment						
Intervention	2.14	1.05, 4.33	5.52	2.21, 13.78	4.24	2.02, 8.87
Control (reference)						
Education, currently attending						
Junior High school			3.49	1.62, 7.52	2.68	1.33, 5.39
Primary school (reference)						
Health literacy - reading level [4]						
Grade 6 reading or above	3.74	2.18, 6.42	2.03	1.03, 3.97		
Below grade 6 reading (reference)						
Baseline interactive nutrition literacy (INL)						
High baseline INL					2.04	1.04, 3.97
Low baseline INL (reference)						
Food choices						

"I choose to eat iron rich foods like beans, kontomire and animal foods."	2.67	1.36, 5.22
"I do not choose to eat iron rich foods like beans, kontomire and animal foods. " (reference)		

Adjusted intention-to-treat analysis was conducted using a general linear mixed model with cluster-level random effects. Clustered by school-based girls' club. The adjusted models included the variables with a significant ($p<0.05$) unadjusted odds ratio. Only those variables that were significant ($p<0.05$) in the adjusted model were retained.

Functional, interactive, and critical nutrition literacy were measured using an adapted self-assessment questionnaire. Responses to series of self-assessment statements were provided per domain of nutrition literacy on a 5-point Likert scale from strongly disagree to strongly agree, then categorized into a binary score. A cumulative score was tabulated and was dichotomized using a predetermined threshold resulting in a binary score (0=not critically literate, 1=critically literate).

1 The saturated model for functional nutrition literacy included treatment, education – currently attending, health literacy reading level, baseline functional nutrition literacy, and baseline interactive nutrition literacy.

2 The saturated model for interactive nutrition literacy included treatment, education – currently attending, health literacy reading level, baseline interactive nutrition literacy, baseline food choice – to choose to eat iron rich foods – when purchasing a meal for oneself.

3 The saturated model for critical nutrition literacy included treatment, education – currently attending, baseline interactive nutrition literacy, and baseline food choice – to choose to eat iron rich foods when purchasing a meal for oneself.

4 Health Literacy reading grade level was assessed using the validated REALM-teenS tool. Grade level was then dichotomized based on a predetermined threshold that, grade 6 – health information is primarily written at a grade 6 english reading level, where 1= grade 6 reading level or above, 0= below grade 6 reading level.

Table 3.3a – Summary of intention-to-treat results of participatory video intervention on adolescents' food knowledge, food purchasing choices, and daily food consumption of a balanced diet

	Model 1. Food knowledge about balanced diet		Model 2. Food choice about balanced diet		Model 3. Daily consumption of Grow foods category[2]		Model 4. Daily consumption of Glow foods category[2]	
	AOR[1]	95% CI	OR	95% CI	β	95% CI	β	95% CI
Treatment								
Intervention	7.31	2.38, 22.50	8.92	1.49, 53.48	-0.08	-0.49, 0.32	0.15	-0.02, 0.62
Control (reference)								

[1]Adjusted odds ratio. Initially, saturated models using general linear mixed methods with cluster-level (school) random effects, included treatment plus any covariates that were significantly associated with the outcomes in unadjusted bivariate analyses. Food knowledge (*"I am familiar with Go, Grow, and Glow foods.")* was associated with education, health literacy reading level, baseline critical nutrition literacy, and one of the baseline food choices (*"I choose to eat iron-rich foods")*; however, only the first two covariates were retained in the final adjusted model. No variables were significant in bivariate analyses for food choice ("*I choose to eat from all the food groups")* and the two daily consumption outcomes and the final models include only treatment.

[2] Daily food group consumption was measured using a non-quantitative food frequency questionnaire and categorized in accordance with Ghana Health Service *Go, Grow, and Glow* dietary recommendations. (Nutrition Department Ghana Health Service, 2009) Grow food category: (1) organ meats, (2) meat such as beef, pork, lamb and goat, (3) poultry, (4) fish, shellfish, or other seafood, excluding powdered fish, (5) food made from legumes, beans, nuts, or seeds, (6) milk and milk products, and (7) eggs. Glow food category: (1) yellow or orange vegetables, (2) dark green leafy vegetables, (3) turkey berry (*Solanum torvum*), (4) okra, garden egg, or plantain, (5) tomatoes, (6) vitamin C-rich fruits, and (7) other fruits.

Table 3.3b – Summary of intention-to-treat results of participatory video intervention on adolescents' food knowledge, food purchasing choices, daily food consumption of iron-rich foods

	Model 1. Food knowledge about iron-rich diet		Model 2. Food choice about iron-rich diet		Model 3. Daily consumption[2] of local iron-rich plants and dark-green leafy vegetables[3]		Model 4. Daily consumption of meat[4]		Model 5. Daily consumption of fish[5]	
	AOR[1]	95% CI	AOR	95% CI	AOR	95% CI	OR	95% CI	OR	95% CI
Treatment										
Intervention	6.44	1.21, 34.38	11.77	2.32, 59.78	1.37	0.85, 2.20	1.23	0.27, 5.72	2.12	0.63, 7.07
Control (reference)										

[1]Adjusted odds ratio. Saturated models were made using general linear mixed methods with cluster-level (school) random effects, included treatment plus any covariates that were significantly associated with the outcomes in unadjusted bivariate analyses. Only those variables that were significant ($p<0.05$) in the adjusted model were retained. Adjusted model for daily consumption of local iron-rich plants and vegetables included treatment and baseline Interactive Nutrition Literacy. No variables were significant in bivariate analyses for food knowledge *("I understand what food I need to eat to have good level of iron in my blood." and "I understand what can happen to my body when I don't get enough iron from the food I eat."),* food choice *("I choose to eat iron rich foods like beans, kontomire* (*Xanthosoma sagittifolium*), *and animal foods")* and the daily consumption of meat or fish.

[2] Daily food consumption was measured using a non-quantitative food frequency questionnaire

[3] Local iron-rich plants and vegetables include: dark green leafy vegetables such as kontomire, aleefu (*Amaranth cruentus*), bokoboko *(Talinum triangulare)*, ayoyo (*Corchorus olitorius*), and turkey berry (*Solanum torvum*).

[4] Includes beef, pork, lamb, goat, chicken, guinea fowl, and organ meats.

[5] Includes fish, shellfish, or other seafood, excluding powdered fish.

Bridge II

The previous chapter assessed the effectiveness of a participatory video-making nutrition intervention on the CNL of adolescent participants. The cluster randomized controlled trial offered evidence that a participatory video-making intervention is a viable educational model because intervention participants experienced a 4-fold increase in CNL and a significant difference in personal food choices. These results also provided evidence to support the CNL framework (Figure 1.1) that proposes that improved CNL is manifested in a change in personal behaviour such as food choice and purchasing habits. Though the intervention adolescents improved their food choices when purchasing a meal for themselves, there were no group differences in the daily food consumption of dark-green leafy vegetables, meat, and fish. Further research can help us understand the factors that influence adolescent diet that are outside of their control. For example, though adolescents may want to change their dietary behaviour, they might not have an influence on the accessibility and availability of the recommended food items, or household decisions regarding what food is procured and consumed.

Additionally, little is known of the environmental factors that influence adolescent diets in LMICs (Carducci et al., 2021; Neufeld et al., 2021). The following chapter contributes to this research gap. Participatory video-making activities were used to identify the challenges adolescent girls faced in getting a balanced and iron-rich diet in the UMKD of Ghana. (Kindon, 2003; Mitchell et al., 2017; Servaes, 1996). Participatory video-making has been used in the past to study topics that interest both researchers and the local population. It involves community members reflecting on their lived experiences, identifying strengths and challenges, and

communicating the issues and realistic approaches to bring about the desired change. The participatory video intervention presented in Chapter 3 included reflexive and analytical exercises to encourage the adolescents to observe their food environments and to reflect on the challenges they faced to get a balanced diet and iron-rich foods. Chapter 4 describes the inductive thematic analysis of two sets of data: (1) cognitive maps of the myriad challenges they faced and (2) produced videos on the challenges they deemed most urgent. These maps and videos provided a visual representation of the perceived factors that underpin adolescent nutrition in this rural district of Ghana – information that can help inform policies and programs that aim to improve adolescent nutrition.

CHAPTER IV.

Adolescent girls' perceived barriers to a balanced diet and iron-rich food in rural Ghana: grounded theory from a participatory video intervention[3,4]

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Submitted to the Journal of Global Health: Science and Practice

[3] Source of financial support: The Canadian Queen Elizabeth II Diamond Jubilee Scholarships (QES) is managed through a unique partnership of Universities Canada, Rideau Hall Foundation (RHF), Community Foundations of Canada (CFC), and Canadian universities. The QES-Advanced Scholars Program is made possible with financial support from International Development Research Centre (IDRC) and Social Sciences and Humanities Research Council (SSHRC).
[4] Conflict of interest and funding disclosure: Mona Z Ghadirian, Grace S Marquis, Naa D Dodoo, and Neil Andersson declare no conflicts of interest.

Abstract

Introduction: Inadequate dietary intake contributes to poor nutritional status indicators including iron deficiency anemia. The 2017 Ghana Micronutrient Survey estimated that over 25% of non-pregnant adolescent girls, 15 to 19 years of age, were anemic – signaling a national public health concern. This study aimed to actively involve adolescent girls in identifying the challenges they faced to acquiring balanced and iron-rich diets in rural Ghana.

Methods: A 2018-19 cluster randomized control trial (clinicaltrials.gov NCT03704649) selected 20 schools in one Ghanaian rural district and enrolled girls aged 13-16 years. All schools received a nutrition curriculum for their girls' clubs. The 181 girls in the 10 intervention schools also participated in a series of activities to develop a cognitive map of the major challenges they encountered to get a balanced diet. Adolescents voted for the most pressing challenge, devised solutions, and depicted them in a short video that they planned, acted, filmed, and screened with their classmates. This process was repeated in all intervention schools to produce a second video on the topic of iron-rich diets. A total of 20 cognitive maps and 20 videos were created. This paper presents the inductive thematic analysis of the cognitive maps and videos produced by the adolescents in the intervention schools.

Results: Adolescents' agency was limited by their lack of decision-making power at home and lack of purchasing power at school. When they could make their own food choices, their decisions were shaped by a lack of food knowledge and preference, and was limited by the availability of animal-sourced foods, fruits, and dark green leafy vegetables. Availability of these nutrient-rich foods was shaped by the knowledge and priorities of gatekeepers of adolescent diet - parents at home and canteen staff at school. Common family agricultural practices of cutting

down and spraying dark green leafy vegetables with weedicide negatively affected the availability of iron-rich foods in the home. It was also common practice for caregivers to sell iron-rich foods for financial gain instead of consuming them in the home.

Discussion: Involving adolescents in an active reflection of their food environments exposed a range of diet-related challenges at home and at school. As parents and school staff were key influencers of adolescent diet within these settings, future adolescent nutrition promotion initiatives should involve them.

Key words

participatory video; cognitive mapping; food environment; anemia; adolescent girl; Ghana

Single overriding communication objective

Adolescent food choices in rural Ghana were influenced by their lack of decision-making at home, purchasing power at school, food knowledge, and preference. Family and school canteen staff were gatekeepers for the availability of nutrient-rich foods.

Key findings

- Adolescent girls' diets in rural Ghana were limited by internal and external barriers in knowledge, access, availability, and agency.
- Diet in the home was influenced by family knowledge and household agricultural practices and market behaviors.
- Diet in the school environment was influenced by girls' knowledge, preferences, and purchasing power as well as canteen staff knowledge and entrepreneurial activities.

Key implications

- Policy makers and program developers should include parents and school staff a key influencer of adolescent health and nutrition in the home and school food environments.
- Research should consider implementing participatory video methodology as a viable model to provide a framework for adolescents to actively reflect about their environments and communicate issues they deem urgent.
- Program developers should support adolescents' involvement in shaping their health and nutrition environments.

Introduction

Addressing adolescents' nutritional needs contributes to current physical and cognitive development as well as positive health outcomes in adulthood and future generations [1]. Since 1975, however, there has been minimal decline in iron-deficiency anemia, underweight, and stunting in adolescent girls globally, and overweight has increased [2,3]. In Ghana, the prevalence of stunting and thinness has remained stagnant from 2003 to 2014, and overweight and obesity has increased among adolescent girls, aged 15-19 years during that time [4]. Despite increased government efforts to address iron-deficiency among adolescent girls, over 20% of non-pregnant Ghanaian girls, 15 to 19 years of age, were iron-deficient (serum ferritin < 15.0 µg/l) in 2017 [5]. The dietary patterns of Ghanaian adolescents are currently understudied. One study showed that junior high school students in Ghana preferred high sugar and fat content food products [6]. This is consistent with the results of a systematic review that reported high consumption of energy-dense nutrient-poor foods and low dietary intake of dairy, meats, fruits, and vegetables among adolescent girls in low- and middle-income countries (LMIC) [6,7]. More research is necessary to identify and address the challenges adolescent girls face to get a balanced and iron-rich diet.

An in-depth understanding of the forces that influence adolescents' dietary intake and food choices is required to better address adolescent malnutrition. Adolescents' dietary intake occurs within different food environments (home, school, and markets) where they interact with food systems to obtain, prepare, and consume food [8]. Food environments are made up of physical, economic, and socio-cultural factors that play a role in informing food choices and shaping dietary patterns. Although conceptual frameworks have been proposed to explore the influence of food environments on dietary patterns, they rarely include adolescents [9-11].

Adolescents are at a distinctive life stage, marked by unique nutritional needs. They have greater autonomy and responsibility than their younger counterparts and are more susceptible to changes in food systems than adults [9]. The recent development of *The Innocenti Framework for Food Systems and Children's and Adolescents' Diets* has helped to conceptualize the relationship among different food system drivers (e.g., socio-cultural), determinants (e.g., caregiver and adolescent behaviors), and their influencers (e.g., intra-household dynamics) on adolescent diet [12]. The majority of studies on adolescent food environments have been conducted in high-income and upper-middle-income countries. Very few studies have considered adolescents from LMICs who may be exposed to unique challenges [10]. Traditional food environments are prominent in rural LMIC settings, where people rely mainly on growing their own food and purchasing food from local markets and neighbors' kiosks (HLPE, 2017). Limited food availability and accessibility are common [13]. Research about adolescents' diet-related challenges in traditional food environments is lacking and may provide an opportunity for policy makers and service providers to tailor programs to adolescents' needs [14].

Conventional research places adolescents as the object of study rather than as partners or co-researchers [15]. The United Nations Youth Strategy call to action underscores that service providers often do not fully understand adolescent needs [16]. Actively engaging adolescents in the development of the policies and programs that affect them can address this challenge [16]. Participatory research invites adolescents to play an active role in the generation and application of knowledge and posits that their involvement benefits the research process, their own development, and the development of their communities [17]. This study aimed to actively involve Ghanaian adolescent girls to take a leadership role in identifying their challenges to get a

balanced and iron-rich diet and make their own educational videos about the most pressing challenges they faced.

Methods

A video nutrition education intervention was implemented with a participatory research approach with adolescent girls in rural Ghana. This was part of a 2018-19 cluster randomized control trial that investigated the effectiveness of a participatory video intervention on participants' nutrition literacy. As part of the participatory video-making process, adolescents joined discussions and cognitive mapping activities to explore elements of their food environment and to identify the challenges they faced in getting balanced and iron-rich diets. The videos the girls produced also depicted their lived experiences and thoughts about the most pressing challenges they faced. This paper presents the analysis of the cognitive maps and participatory videos these adolescent girls produced. In doing so, it offers a depiction of the diverse challenges Ghanaian adolescent girls encountered in a traditional food environment and identifies the challenges adolescents considered urgent.

Collaborators

The project team was composed of the lead researcher (MZG) and project staff. This researcher, a female Canadian-born doctoral candidate, oversaw all components of the research. The project staff were four local Krobo-speaking women who had experience in qualitative data collection and were responsible for implementing all intervention and data collection activities. We convened a local stakeholder Community Advisory Board (CAB) of four men and one woman. The CAB included representatives from a school management committee, religious institution, financial institution, Ghana Health Service, and Ghana Education Service. The CAB met with

the researcher each month to refine the intervention and research method. They participated in the evaluation, developed, and implemented a community knowledge mobilization plan.

Choosing the intervention foci and research objectives

The lead researcher and the CAB were involved in choosing the nutritional issues that became the foci of the participatory video intervention. The lead researcher reviewed academic literature about adolescent nutrition and reviewed nationally representative statistics to better understand adolescent girls' nutrition issues. She also conducted related in-depth interviews and focus group discussions with community members, traditional leaders, and health and non-health staff at the national and district level between September and November 2017. Based on these preliminary activities (*results not presented)*, in October 2018, the lead researcher proposed four nutrition issues to the CAB. After discussion, the CAB consensus for research foci was: (1) What prevents adolescent girls in the Upper Manya Krobo district from acquiring a balanced diet? (2) What hinders them in preventing iron deficiency anemia?

Sample

A cluster randomized control trial included 20 schools (10 intervention, 10 control) from December 2018 to July 2019 to improve the nutrition literacy of rural adolescent girls in the Upper Manya Krobo district. The inclusion criteria for schools were that they hosted girls' club gatherings, had junior high school classes, and were within a 30-minute driving radius of the district capital. The participant inclusion criteria were (i) female 13 to 16 years of age, (ii) Krobo-speaking, and (iii) present in their girls' club on the day of enrollment. All schools were provided with a nutrition education curriculum on balanced diet and anemia for the girls' clubs.

Adolescents were taught how to apply Ghana Health Service's *Go, Grow, Glow* principle to their meals to get a balanced diet that contained food from all three food groups: 1) energy-giving "Go" food (fats, oils, and starchy food), 2) body-building "Grow" food (animal-sourced food, beans, and nuts), and 3) protective "Glow" food (fruits and vegetables) [18]. Adolescents were also taught about iron-deficiency anemia and the importance of acquiring an iron-rich diet through local animal-sourced foods and dark green leafy vegetables, in addition to vitamin C-rich fruits.

Each intervention school participated in a series of activities where adolescents 1) discussed and identified the most pressing challenge they faced in getting a balanced diet, 2) thought of practical solutions to their challenge, and 3) planned, acted, and screened an educational video on the topic. This process was repeated with all intervention schools a second time on the topic of iron-rich diets. This study uses data from these intervention activities.

The McGill University REB-III and the University of Ghana Ethics Committee for the Humanities granted ethical clearance for the research to be conducted. It was registered with clinicaltrials.gov (NCT03704649).

Data collection

Cognitive mapping

Adolescents from the intervention schools participated in a series of activities to develop the content of their videos. Two activities, the *Margolis Wheel* and the *Problem Tree*, helped participants draft cognitive maps of the challenges they faced in getting balanced and iron-rich diets [19]. For the former, adolescents were paired off and answered a set of questions. They discussed how they would apply the nutrition curriculum information they received in their girls' club and challenges they have faced in doing so. The girls rotated partners after each question, so that they could have one-on-one conversations with different classmates. In the *Problem Tree*

activity, they individually wrote down the most pressing challenge for the nutrition issue being discussed. Then, they collectively reviewed all the challenges proposed by their peers. Using inductive thematic analysis, adolescents organized the challenges into themes, resulting in a cognitive map of the challenges they deemed important. Participants were not given an *a priori* theoretical framework or pre-existing code frame. Adolescents reviewed the themes they generated in their cognitive map and cast an anonymous vote to identify the most pressing challenge in their community. They then discussed viable solutions to the challenge with the most votes.

Video production

Adolescents drafted a storyboard, improvised dialogue, acted, filmed, and screened a dramatized video representing their lived experience about the pressing challenge and proposed solution. The intervention activities, including the video production, were conducted in the local dialect of Krobo. The videos were translated and transcribed into English subtitles. The sources of data for the present analysis were the 20 cognitive maps and the 20 participatory videos produced by the adolescents in the 10 intervention schools.

Data analysis

Data analysis occurred in two phases. In phase 1, the lead researcher and project staff combined the cognitive maps (comprised of a poster board with sticky notes that the adolescents organized into themes) from the different schools by nutrition topic. Each sticky note response was read out loud. The lead researcher and project staff conducted rounds of first cycle coding to review the "responses" and themes in the cognitive maps to better understand the themes the adolescents generated. A second cycle of coding was used to identify obstacles across the schools. In phase 2, the lead researcher coded the actions and dialogue in the videos to develop themes using

MaxQDA2020 [20]. The reflexive thematic video analysis was conducted to provide context to the adolescents' perceived obstacles and to identify relationships between different challenges [21]. Results were presented to local field staff for member checking.

Results

The analysis included data from 181 girls in the 10 intervention schools who were 14.3 ± 1.0 y at recruitment. Sixteen percent of the students (n = 29) were enrolled in primary school (grades 4 to 6) and 84% (n = 152) were enrolled in junior high school (levels 1 to 3). The Upper Manya Krobo district was primarily rural and underserviced. For example, only 49% (n=89) of the participants reported having electricity and only two adolescents reported having piped water in the home.

In the cognitive mapping exercise at the beginning of the intervention, the adolescents identified a variety of challenges they faced in acquiring 1) a balanced diet and 2) an iron-rich diet. These challenges fell into four overarching categories – knowledge, availability, access, and adolescent agency (Table 1). The majority of these challenges occurred in the home and, secondly, at the school canteen. Adolescents acknowledged that their diet was influenced by a lack of knowledge about the components and benefits of eating balanced and iron-rich diets. The cognitive maps commonly included a lack of availability (supply of nutrient-dense foods in communities, schools, and homes) and access (having the resources necessary to acquire nutrient-dense foods) to a variety of foods – primarily fruits, animal-sourced food, and dark green leafy vegetables. They noted caregivers' agricultural practices and household selling and spending habits limited the availability of these foods. Adolescents reported having little decision-making power about what food was available or prepared in their homes. When they

were able to exercise agency by purchasing food for themselves, they often preferred purchasing nutrient-poor sweets.

The analysis of the adolescents' videos provided insight into their perception of the inter-relationships between challenges identified in the cognitive mapping exercise (Table 2). For example, the influence of caregivers' agency and behavior was illustrated when one of the adolescent actors played a 'caregiver' who sold iron-rich food instead of using it for meals at home because of a lack of knowledge about its nutritional benefits, food preferences, and the desire for financial gain.

There were some challenges that were more prominent when acquiring a balanced diet versus an iron-rich diet (Figure 1). Adolescents perceived that the most pressing issues to acquiring a balanced diet were a lack of nutrition knowledge, poverty, and limited availability and access to a variety of healthy food options in their school canteens and homes. In contrast, caregivers' buying and selling habits and poor agricultural practices were obstacles that took precedence in their discussions and videos about having iron-rich foods to prevent anemia. Below, the four categories of challenges are explored in depth.

Knowledge

The girls described a lack of awareness among themselves and their caregivers about the influence of one's diet on health outcomes – physical appearance, growth, and prevention of disease. More specifically, they acknowledged that they were not mindful of the benefits of fruits and vegetables – particularly local dark green leafy vegetables and plants like kontomire (*Xanthosoma sagittifolium*), alefu (*Amaranth cruentus*), ayoyo (*Corchorus olitorius*), and turkey berry (*Solanum torvum*). Adolescents acknowledged that these foods were grown in their villages but not often harvested and consumed because they were unaware of the benefits or how

to prepare and include them in their meals. A number of the adolescents' videos referenced fruits and vegetables going unused and rotting on their farms. Adolescents believed that their caregivers would increase the procurement and consumption of fruits and dark green leafy vegetables if they knew of their benefits. An improvised scene in one of the videos had a mother reflect about her family saying, *"at first when we did not know about [a balanced diet], we had been eating only one-way foods. Go to the farm and see how the fruits are getting rotten, the kontomire is also drying up, and we are just selling them,"* (Video V1-S14). Here, "one-way" foods referred to the regular consumption of one type of food for multiple meals – often carbohydrate-rich staple foods like banku (maize and cassava), fufu (cassava and/or plantain or cocoyam), gari (cassava), or kenkey (maize).

Caregivers and community members were portrayed as holding misconceptions about nutrition and the causes of anemia in six of the 20 videos. Misconceptions included (1) eating well being synonymous with eating a lot, (2) eating fruits after a meal causing stomach pain and sickness, and (3) symptoms of anemia being attributed to a "spiritual attack". The adolescent girls countered these misconceptions in their videos. For example, in one video the student character concluded that her anemia was not a spiritual attack since *"spirit will not make me walk and feel dizzy. Some people are lying that [anemic symptoms are] spiritual,"* (V2- S11 video).

Availability

Availability refers to the supply of nutrient-dense foods in communities, schools, and homes. A shortage of fruits, animal-sourced food, and dark green leafy vegetables in school canteens and homes was a common challenge to acquiring balanced and iron-rich diets. The low availability of nutritious options in the school canteens was commonly addressed in the videos. School

canteens primarily sold affordable starchy foods like fried yam or kenkey as well as a variety of sweets (e.g., toffees and ice cream). Fruits and iron-rich foods like fish, meat, and dark green leafy vegetable stews were infrequently available in canteens. Adolescents acknowledged that their purchasing habits influenced the supply of available food as canteen sellers responded to students' demands for their preferred unhealthy food options.

Low household availability of fruits, animal-sourced food, and dark-green leafy vegetables was a more complex issue. Adolescents underscored the influential role of their caregivers in shaping what foods were available in the household and identified common patterns of caregiver behaviors that hindered the availability of nutritious and iron-rich food. There were two common behaviors that reduced their availability in the home – agricultural and market practices. Caregivers' common agricultural practices were to 1) not plant iron-rich crops like kontomire, ayoyo, and turkey berry 2) not harvest existing plants for consumption, and 3) cut down or spray existing plants with weedicide to use the land for more profitable crops. Adolescents from a peri-urban school setting stated that poor animal husbandry hindered the availability of iron-rich plants. It was common practice to not fence or tie goats that would eat or destroy plants. In their video, the adolescent actor tells the village queen mother, *"My husband passed away. This garden is the only thing he left for me to take care of my children. I have been using ayoyo, kontomire, turkey berry, etc. to prepare food for the children. The [neighbor's] goats destroyed everything in the garden,"* (Video V2-S10).

Caregiver market habits were explored in numerous videos. Caregivers from households that harvested dark-green leafy vegetables or reared small animals (e.g., goats or chicken) often sold their production for profit rather than use them for home consumption. Three reasons were attributed to this caregiver behavior – (1) ignorance about the nutritional benefits of the food, (2)

the desire to acquire wealth, and (3) their personal disinterest in eating these foods (e.g., kontomire). In addition, adolescents highlighted their caregivers' habit of spending household funds on non-food items, such as clothes, jewelry, and silverware.

The environment also influenced the availability of nutrient-dense crops. In a video about acquiring balanced diets, one of the adolescent actors played a mother speaking to a nurse about the dietary intake of her ill children. In the scene she said, *"during the rainy season, our crops yielded well. […] I could buy all those [diverse foods] for the household but now that the rain is not frequent, I could not buy all those things again. So, I would prepare gari and palm oil for them and they eat for school, then after school too, they will come and eat the same thing,"* (Video V1-S15).

Finally, the diversity of market vendors determined the availability of different types of foods and agricultural supplies like seeds and seedlings. Availability was further compromised by long distances to weekly food markets. In a video, a student who was previously diagnosed with anemia shared with her classmates that *"my mother realized that [dark green leafy vegetables, beans and meat] are not in our community here. We only get them on market days, but only kontomire and turkey berry. Not everything. So, my mother travelled to [a different town] and bought the seeds [to plant them in a home garden*],*"* (Video V2-S12).

Access

Access here refers to the individual having the resources necessary to acquire nutrient-dense foods. Poverty was the most common factor that hindered access. Adolescents perceived that the lack of money to buy themselves food at school was related to household poverty and the

caregivers' custom of providing limited money to their daughters for food at school. The adolescents reported that their limited purchasing-power at the school canteen resulted in the purchase of economical, carbohydrate-rich foods instead of meals that included fish or meat, when available.

Adolescents explained how gender norms and qualities among community members contributed to the inequitable distribution of nutrient-rich foods. Adolescents from one school explained how households in their village prioritized men when meat was prepared. In one video, an adolescent playing the role of a father confronts his wife who had suggested that they provide more meat to their daughter. In the scene he said, *"I am the man that married you and I always suffer to get you money to buy fish. You are telling me to eat [a smaller quantity so that] your daughter [eats] more fish?"* (Video V1-S18). Finally, adolescents attributed characteristics of their community members to the quality of their diets. They argued that the lack of love and generosity as well as the presence of greed in the community hindered the access to important information, food, and resources that could have positively contributed to their diet. One participant shared the following, *"[the community members] do not love each other so they do not teach each other about balanced diet. If someone knows about balanced diet but I do not love my community, I will not want to spread the knowledge."* (1S10 – cognitive mapping exercise)

Adolescent agency

Adolescent agency is defined here as the ability to make and follow through on one's choices. Many adolescents highlighted that when they had money and made their own food choices at school, they often preferred sweets and starchy foods. Adolescents shared their preference for sweets over fruits, and starchy foods over stews containing dark green leafy vegetables. At

home, the girls reported having limited decision-making power about the food that was available or prepared.

Discussion

This study presented the perceived challenges adolescent girls faced in acquiring balanced and iron-rich diets in rural Ghana. The most commonly reported challenges were 1) a general lack of knowledge about the benefits of a balanced and iron-rich diet, 2) the low availability of fruits, animal-sourced food, and dark green leafy vegetables in the home and school, and 3) limited access to these foods due to poverty and inequitable gender norms. Though participatory visual research methodologies like photovoice are gaining popularity, this is the first reported trial of a participatory video intervention that we are aware of, that explored challenges in adolescents' traditional food environments with youth creators.

Nearly 90% of the 1.2 billion adolescents in the world reside in LMICs where food environments are complex and understudied [22]. The majority of adolescent food environment research has focused on high-income and upper-middle-income countries and has overlooked traditional food environments that characterize rural LMIC settings [10]. This study, located in rural Ghana, highlighted the personal and environmental factors that inform our understanding of adolescent interactions with traditional food environments. It also illuminated gaps and challenges that provide insight to program- and policy-makers who aim to improve adolescent diets.

The results of this study corroborate the need for an adolescent-specific conceptual framework. Adolescents do not face the same challenges as adults. Intra-household dynamics

plays an important role in shaping adolescent diets and this dynamic is often not integrated into food-systems approaches. Caregivers remain important influencers of adolescent diets despite adolescents' increased autonomy and agency [23]. In our study, the primary challenge to having nutrient-rich foods available for meal use in the home was related to caregiver agricultural and market practices. Caregivers often retain decision-making power over what food products are sold and what food is procured, prepared, and consumed, such as the practice of having girls being fed last and least [24]. Compared to adults, adolescents have limited agency in the home. Adolescents also have interactions with the school food environment and are subject to decisions of school canteen sellers [9]. Girls in this study shared challenges that have been noted among adolescents from other parts of the world such as the lack of time for food preparation leading to the consumption of convenience foods and the preference of energy-dense, nutrient-poor sweets [25,26]. This suggests that adolescents may experience some common diet-related challenges to varying degrees, irrespective of food environment. Some of the challenges are circumstantial to traditional environments. Limited availability and poverty often define traditional food environments and play an influential role in shaping adolescent food choices – challenges that are not as prominent in mixed and modern food environments [14].

Farming was commonly practiced among the adolescents' households. Constraints such as the lack of access to seeds, land tenure, and agricultural training can impede farmers from diversifying food production [27]. These families produced their own food and supplemented it with purchases and trades made at weekly markets and kiosks where fresh produce and animal-sourced food are procured. The caregivers often prioritized farming profitable crops over diversifying food production. In this traditional food environment, the supply chain is greatly influenced by local production from a network of villages. The decisions that small-scale farmers

make about production and market sales influence the choices that are available for the diets of their and their neighbors' households. This influence on the food supply chain is not captured by the *Innocenti framework*. In traditional food environments, the decisions of caregivers might have substantial influence on the food supply chain and ultimately the food consumed in the household. This is an area where further research is needed.

Conclusions

This study is limited by the experience of our demographic – female adolescent students. The results may not be representative of the diet-related issues for those outside of the rural school system. Most nutrition studies with adolescents in LMICs are conducted within the school environment – further research is needed to better understand those issues of adolescents that do not or cannot attend school. The nature of participatory cognitive mapping is that everyone's views are reliant on their own limited lived experiences [28]. The challenges the girls identified were limited to their awareness of their food environment. For example, they might have had limited knowledge of the dynamic challenges along the food supply chain and therefore it was not a prominent factor in their cognitive maps. The study is also limited in its video analysis. Although the participants were tasked to represent their lived experiences of the challenges they identified, the videos themselves were not documentaries, but rather improvised dramatizations. Though the participants watched and confirmed that the videos were an accurate representation of their lived experiences, the videos are actually an audio-visual representation of the adolescents' perceived reality. It is important then not to associate the actions and conversations represented in the videos as quotes from actual community members but rather reflect the participants' attempts to present the challenges they faced through improvised dialogue.

Involving adolescents in an active reflection of their food environments, through cognitive mapping and video-making activities, can facilitate a more profound understanding of the diet-related challenges they face at school and at home. Furthermore, it can pinpoint tangible opportunities to address the constraints in their food environment that impede them from getting balanced and iron-rich diets. This study highlights the challenges and influencers that have shaped adolescent diets among girls in traditional food environments. Adolescents have the desire to exercise their autonomy and agency and should be equipped with the knowledge and tools to make informed food choices. As schools are the primary environment where adolescent girls exercise their purchasing power, efforts should be made to include adolescents to govern the food options provided in school canteens. Nutrition education initiatives should be tailored to empower major actors that influence adolescent diets - primarily adolescents themselves, their caregivers, and school staff. In addition, initiatives that link local farmers and school canteens may secure a market and incentivize the diversification of food production.

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Figure legend

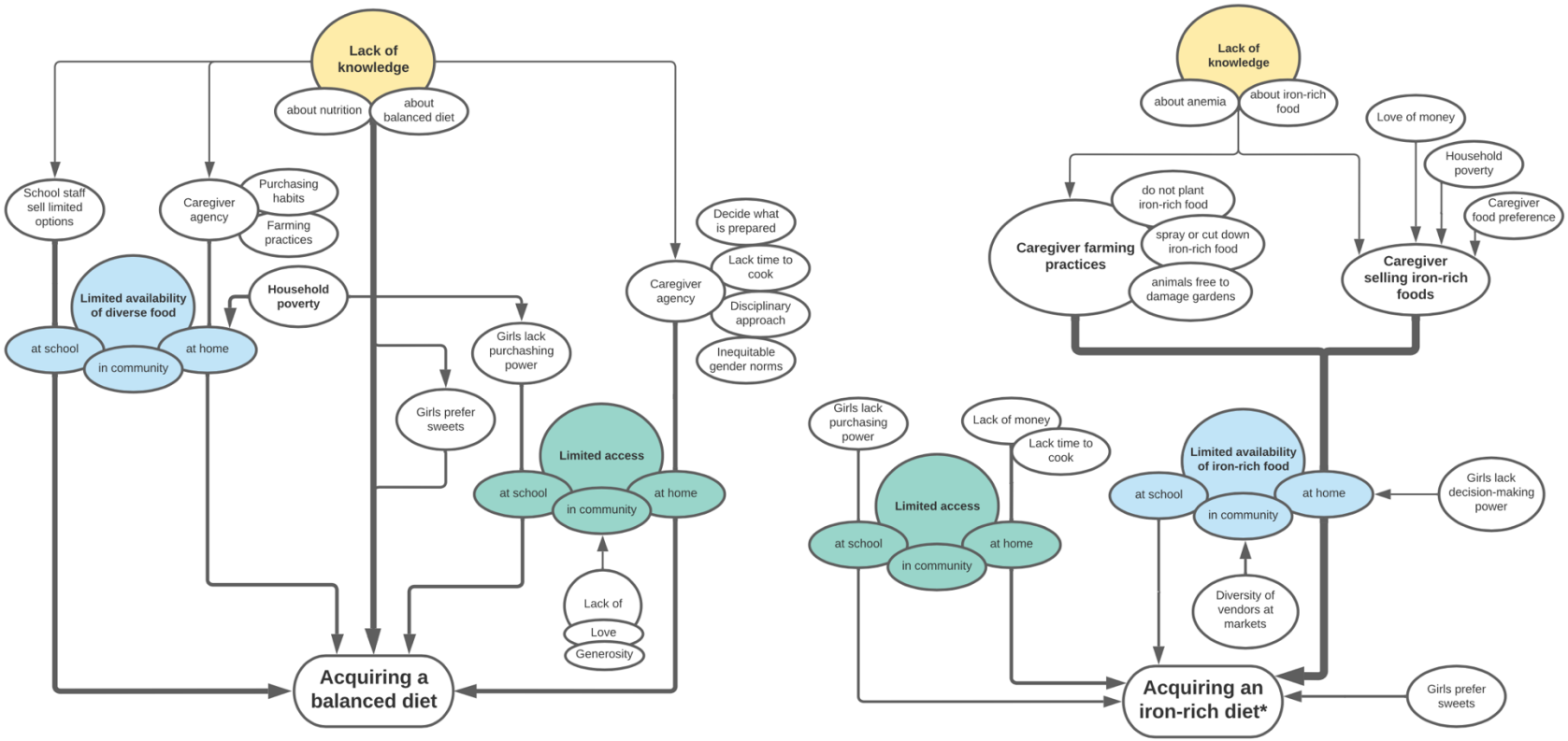
Figure 4.1 – Perceived challenges rural adolescent girls faced to acquire a balanced diet and iron-rich diet – as described in a participatory video nutrition intervention in Ghana.

Table legend

Table 4.1 – Perceived challenges adolescent girls faced to acquire a balanced or iron-rich diet at home, school, and in their communities - as described in a participatory video nutrition intervention in Ghana

Table 4.2 – Samples of dramatized dialogue about challenges in the home to acquire a balanced and iron-rich diet, as performed by female adolescents in participatory videos in rural Ghana.

Figure 4.1 – Perceived challenges rural adolescent girls faced to acquire a balanced diet and iron-rich diet – as described in a participatory video nutrition intervention in Ghana.



Thickness of arrows reflects magnitude of influence determined by the frequency the participants identified the challenge as the most pressing.
Balanced diet refers to Ghana Health Service *Go, Grow, Glow priniciple.* According to this principle, a balanced diet contains food from all three food groups: 1) energy-giving "Go" food (fats, oils, and starchy food), 2) body-building "Grow" food (animal sourced-food, beans, and nuts), and 3) protective "Glow" food (fruits and vegetables).
* Adolescents were asked to identify challenges they faced in preventing iron-deficiency anemia through an iron-rich diet.

Table 4.1 – Perceived challenges adolescent girls faced to acquire a balanced or iron-rich diet at home, school, and in their communities - as described in a participatory video nutrition intervention in Ghana

Categories of challenges	Home	School	Community
Knowledge	- Caregivers were unaware of the dietary needs of adolescent girls, how nutrition influences health outcomes, and how to prepare diverse foods	- School canteen staff were not aware of dietary needs of adolescent girls - Adolescents were unaware of the benefits of purchasing healthier canteen options	- The community were not aware of the dietary needs of adolescent girls, nor the benefits of eating balanced and iron-rich diets
Availability	- Caregivers' agricultural and market practices reduced availability of nutritious and iron-rich food - Fruits or iron-rich food were left unharvested in the farm - Iron-rich crops were cut down or sprayed with weedicide - Iron-rich crops were sold for profit instead of home consumption - Household income was used for things other than food	- School canteen lacked a variety of food – particularly fruit, meat, and dark green leafy vegetables	- Infrequent and distant markets also had limited diversity of food and agricultural supplies - Poor animal husbandry practices damaged neighboring gardens - Environmental seasons influenced the yield of some crops
Access	- Household poverty - Household lacked access to land or seeds for farming - Parents lacked time to cook - Gender norms influenced the inequitable distribution of food - Caregivers reduced access to food as a disciplinary approach	- Adolescents lacked money to purchase balanced meals that included fruit and meat (when available)	- Lack of love and generosity among community members reduced access to nutritious food and nutrition information

Adolescent agency	- Adolescent girls lacked decision-making power about what food was available or prepared	- Adolescents preferred purchasing and eating sweets and processed food	- Dietary norms shaped adolescent preferences and purchases of staple foods

Table 4.2 – Samples of dramatized dialogue about challenges in the home to acquire a balanced and iron-rich diet, as performed by female adolescents in participatory videos in rural Ghana.

Category	Quote from participatory video
Knowledge	"*Friend* – Please, does [your daughter] eat well? *Mother* – As you see her, she eats a lot. She eats about 3 balls of banku[1] and at the same time she eats fufu[2] too. She eats a lot. *Friend* – And mom please, does she eat fish? *Mother* – Ooh, we do not have money, so we do not buy fish. As for food, she eats well. *Friend* – And please, has she been eating fruits too? *Mother* – Ooh, we do not have money to buy fruits. But as for the food, she eats well." *Adolescent girl talking to ill friend's mother V1-S19*
Availability	***Household selling and purchasing habits*** "We have kontomire around us and we fill our baskets to sell [it] for just two cedis. Then we use that money to buy ice cream, toffee and chips, and eat. Meanwhile we do not get any nutrients from these things." *Mother talking to husband and friend V1-S18* "*Daughter 1* – Whenever you are going to the market, we have been telling you to give us some of the kontomire. You would not give us and would send it all to the market. *Daughter 2* – […] You would sell it all and use [the money] to buy plates and we do not even use it." *Daughters talking to parents V2-S14* ***Agricultural practices*** "[My wife planted] this cocoyam to spoil the land. And you are telling me not to spray it? […] I will spray (with weedicide) and use the land for cassava so that I can make money." *Father talking to a community member V2-S18*

Access	***Household poverty*** "I have it mind to [eat balanced meals] but I do not have work to do and that is why we have not been eating them." *Mother seeking advice from schoolteacher about ill child V1-S19*
	Adolescents limited purchasing power at school "This is my student. If I am teaching, she will be dozing in class. So, I talked to her [and asked] her how much [money she has] been given to school. She said one cedi. With only one cedi, if she buys kenkey[4], she cannot even buy fish or buy fruit for her to eat so that the food she eats will be balanced" *Teacher visiting parents of ill student V1-S12*
	Time to cook "When we leave the house in the morning around 6, we come back around 6pm. I do not have time to cook for them. So, when we come back from farming, we get something like gari[3] and pepper, and we eat. We eat without fish." *Mother of anemic daughter talking to nurse about household diet V2-S15*
	Gender norms "I will give you fish when your dad is done and there is leftover fish" *Mother giving meal to daughter V1-S18*
Adolescent agency	"We have not given [our daughter] the chance to prepare food for us before. She knew all this [nutrition information] and we did not allow her to cook for us." *Mother of anemic girl speaking to husband after diagnosis V2-S15*

* "One-way" foods refer to the regular consumption of one type of food for multiple meals – often carbohydrate-rich staple foods like [1]banku (maize and cassava), [2]fufu (cassava and/or plantain or cocoyam), [3]gari (cassava), or [4]kenkey (maize).

Bridge III

The definition of CNL – to understand and apply nutrition information to change personal and environmental factors to promote nutrition – implies an understanding of the systems and factors that influence nutrition behaviour and outcomes. In the previous chapter, the participatory video intervention provided an opportunity for participants to reflect on the systems and factors that influenced their nutrition. This provided a better understanding of the various challenges adolescent girls faced to get a balanced diet and iron-rich foods in rural Ghana. During these discussions, participants were encouraged to devise solutions to the challenges they identified. While planning the videos, participants needed to re-imagine a new collective perspective about what positive change could look like in their communities. The video-making provided the girls with an opportunity to articulate tangible approaches to bring about the change they wanted to see in their communities. Consequently, the videos they created were visual representations of this revised collective narrative of what change could look like. Additionally, the adolescent girls often portrayed themselves as agents of change in the videos they created. Since participatory video-making has contributed to social change in the past, it can be presumed that adolescents might enact what they portrayed in their videos to promote change (Mitchell et al., 2017).

Chapter 3 confirmed that the participatory video-making intervention increased CNL. The CNL framework (Figure 1.1) suggests that CNL can be manifested in two overarching ways – 1) in a change in personal behaviour, and 2) in an increased engagement in social action to promote change in the environment around them. The former outcome was measured in Chapter

3. The latter outcome is difficult to predict. The third study sought to evaluate the influence of the participatory video intervention by capturing stories of change from intervention participants after the intervention was completed. It involved intervention participants and local stakeholders in the collection and selection of stories of change using a Most Significant Change (MSC) technique, a participatory evaluation method that can be used when outcomes are difficult to predict and measure (Dart & Davies, 2003). The following study assessed the perceived value and influence of a participatory video intervention among intervention participants and local stakeholders.

CHAPTER V.

Ghanaian female adolescents perceived changes in nutritional behaviors and social environment after creating participatory videos: a Most Significant Change evaluation[5,6]

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Published in Current Developments in Nutrition

[5] All sources of financial support: The Canadian Queen Elizabeth II Diamond Jubilee Scholarships (QES) is managed through a unique partnership of Universities Canada, Rideau Hall Foundation (RHF), Community Foundations of Canada (CFC), and Canadian universities. The QES-Advanced Scholars Program is made possible with financial support from International Development Research Centre (IDRC) and Social Sciences and Humanities Research Council (SSHRC).

[6] Conflict of interest and funding disclosure: Mona Z Ghadirian, Grace S Marquis, Naa D Dodoo, and Neil Andersson declare no conflicts of interest.

Abstract

Background

Understanding the influence of participatory video-making on the nutrition-related behavior of video creators may help shape nutrition education interventions.

Objective

This study assessed the perceived value and influence of a participatory video intervention among participants and stakeholders.

Methods

A 2018-2019 cluster randomized controlled trial (clinicaltrials.gov NCT03704649) selected 20 schools (10 intervention, n=181; 10 control, n=170) in one Ghanaian rural district, enrolled adolescent girls 13-16 years old, and provided a nutrition curriculum. Each intervention school also participated in two series of activities designed to help adolescents plan, film, and screen two nutrition-related videos. The Most Significant Change method involved intervention participants and local stakeholders to assess the value and influence of the intervention – a secondary outcome of the trial. Project staff collected 116 stories of change from the adolescents. Stories described shifts in four domains: participant, peer, and family behavior, and structural changes in the school. Project team used a selection rubric to identify 14 stories that reflected heightened nutrition literacy. Staff conducted interviews with the 14 adolescents whose stories were selected to elaborate on details and perceived resonance. Finally, local stakeholders assessed the stories to identify the four most significant changes of the intervention – one per domain. A separate thematic analysis identified emerging patterns of motivation and action across the 14 interviews.

Results

The chosen Most Significant Change stories revealed how adolescents found creative solutions to acquire iron-rich foods, encouraged neighbors to eat iron-rich foods, taught their family new agricultural practices, and promoted change in their school canteen. Local stakeholders valued stories that addressed common community nutrition issues in a creative and sustainable way, whereas adolescents prioritized stories that showed a change in health outcomes.

Conclusion

Stories of change revealed that the intervention promoted a transformative influence; participants modified their eating habits, lifestyle, and their environment.

Key words

Most Significant Change, narrative methods, participatory research, participatory video, adolescent, nutrition literacy, rural, Ghana, nutrition education

Teaser text

A Most Significant Change evaluation demonstrated the positive influence of a participatory video nutrition intervention on adolescent participants' eating habits and environments.

Introduction

Participatory videos have been used in community development programs to amplify the voices of the marginalized, foster dialogue, educate, and advocate for change (1). This participatory approach enables people to make short films about issues affecting their lives by having control of the video-making process – identifying the topic, developing the content, acting, filming, and screening the video. Unique to these interventions is the potential two-fold influence of 1) the video-making process on the thoughts and behaviors of video creators and 2) the influence of sharing the video on the behavior of those that watch them. Participatory video (PV) is often associated with the concept of community empowerment and social change but the influence of the PV-making process on its creators has not been the subject of rigorous research (2, 3).

Participatory video literature often references Freire's work on critical pedagogy (4, 5) in which he called for the need for educational approaches that enhance critical consciousness (2). He posited that group reflection on images and videos may enhance participants' critical consciousness about their own lived experiences – help them think critically about the world around them and reflect on how best to influence it (4, 5). White (6) further described how PV helps participants to become critically aware of personal and community needs and helps them identify themselves in relation to the community which may give rise to personal, social, and cultural change.

Critical reflection is also a core concept of nutrition literacy, defined as the capacity to access and interpret nutrition information to make informed decisions (7). There are three levels of nutrition literacy: 1) functional literacy, the basic skill of reading and comprehension of nutrition information; 2) interactive literacy, the ability to apply nutrition information to new

scenarios; and 3) critical literacy, the capacity to use nutrition information to analyze one's circumstances and adjust one's personal lifestyle and influential environmental factors (8,9). By definition, both personal and community health stand to benefit from improved critical nutrition literacy (CNL). Despite its potential benefits, the promotion of CNL has seldom been researched. Additionally, there is no current research on the influence of PV intervention on nutrition literacy.

Nutrition education has traditionally relied on conventional forms of social and behavior change communication such as face-to-face counselling and mass media campaigns, which do not foster community-level participation (10). An ongoing challenge for public health practitioners working in communities with low literacy is to effectively share health and nutrition information to promote behavior change (11). Participatory media, such as community radio, is becoming a valued technique for such communities to promote nutrition behavioral change (11). Participatory video has grown in popularity as a means to promote social change, education, and health and has recently been used in nutrition-sensitive programs (11).

Research about the influence of participatory videos on nutrition-related behavior currently focuses on video audiences instead of video creators. In so doing, there is a lack of evidence of the effect of participatory video-making on the nutrition-related behavior of those who produce it, the focus of this study. This paper posits that a PV education intervention could enhance CNL among adolescent video creators and, in turn, have an influence on the lives of participants' as well as the people and environment that surround them. We seek to address another unique research gap. Little is known of the mechanisms through which nutrition literacy interventions affect participants' behavior to promote personal and environmental change. This

study aims to assess stories of change that can reveal how a nutrition literacy intervention influenced participants' personal lifestyles and engagement in social and environmental change.

Methods

The Most Significant Change (MSC) method is a participatory monitoring and evaluation method used to evaluate complex interventions that may have outcomes that are difficult to predict or measure (12,13). The MSC method involves intervention participants and stakeholders in collecting and selecting stories of perceived significant change related to the intervention in question. This method complimented a quantitative evaluation that assessed the changes in adolescent participants' nutrition literacy and lifestyles that were linked to their participation in the PV intervention. We aimed to understand the far-reaching impact of the program, a secondary outcome of the trial, by evaluating the stories of change identified by the participants. Our assumption was that, if the intervention helped adolescents improve critical nutrition literacy, then their friends, families, and surrounding environments may also be influenced. The MSC method was employed to answer the question: "What is the influence of a PV nutrition education intervention on participants' nutrition literacy and behavior, and the perceived impact and value of the intervention to participants and other local stakeholders?" Then, an inductive thematic analysis of interviews with participants was used to answer the question: "How did the participants' experience in the intervention influence their actions?"

Sample

A cluster randomized controlled trial to improve the nutrition literacy of adolescent girls was carried out in 20 schools from December 2018 to August 2019 in the rural Upper Manya Krobo

district, of the Eastern region of Ghana. The criteria for school selection were that they had a girls' club, included junior high school classes, and were within a 30-minute driving radius of the district capital. Schools were randomly assigned to intervention or control arms. All schools in the study benefitted from a nutrition education curriculum. In addition, intervention participants benefitted from activities that built capacity in basic film production, discussion of nutritional issues, and development of educational nutrition videos. An analysis of the positive influence of the intervention on participants' nutrition literacy, food knowledge, and food choices will be published elsewhere. The participant inclusion criteria were (i) female, 13 to 16 years of age, (ii) Krobo-speaking, and (iii) enrolled in a girls' club at the time when consent and assent were acquired. Krobo-speaking field staff presented the contents of the consent and assent form in paper format (in English) and orally (in Krobo) to all guardians and adolescent participants that met the inclusion criteria in gatherings across the 20 schools. They were given ample time to ask questions. A total of 351 girls (intervention n=181; control n=170) met the inclusion criteria and provided informed written assent and their guardians' informed written consent to participate. This paper's MSC and qualitative analysis of participant interviews includes only the intervention schools. Data were anonymized at the point of interview transcription where participants were given an identification number. The primary investigator (MZG) was responsible for the security of identifiable data. McGill University's REB-III and the University of Ghana's Ethics Committee for the Humanities granted ethical clearance for the research to be conducted. It was registered with clinicaltrials.gov (NCT03704649).

Collaborators

The MSC method involved the active participation of the participants, project team, and local stakeholders. The project team was composed of the primary investigator (PI) and project staff. The PI (MZG), a female Canadian doctoral candidate, oversaw all components of the research. The project staff were four local Krobo women who had experience in qualitative data collection and were responsible for implementing all intervention and data collection activities. The local stakeholders made up the Community Advisory Board (CAB) (four men and one woman). They included representatives from a financial institution, a school management committee, a religious institution, Ghana Health Service, and Ghana Education Service. The CAB met monthly to refine the intervention and research methodology, participated in the research evaluation, and developed and implemented a community knowledge mobilization plan.

Study design

In addition to attending their regular girls' club sessions, the intervention schools (n=10) participated in two series of participatory video-making activities. The first series of activities focused on helping participants (n=181) produce a video on the most pressing obstacle related to acquiring a balanced diet. This process was repeated, where each intervention group produced a second video on the topic of preventing iron deficiency anemia. A total of 20 videos were made. The activities were designed to create an interactive environment for participants to reflect together on nutritional issues in their communities, to identify solutions, and to make educational videos to promote change. In the Margolis Wheel activity, adolescents were paired-off to reflect on a set of questions about the nutrition information they were taught (14). The girls rotated partners, so that they could have one-on-one conversations with different classmates. In the

Problem Tree activity, they individually wrote down the most prevalent obstacle and collectively mapped out these responses into common themes. They discussed their importance and voted on what they thought was the most pressing obstacle in their community. They then drafted a storyboard that presented the pressing obstacle and their proposed solution, acted, filmed, and screened their video once with their classmates and school staff. Intervention groups reflected on their experience within 2 weeks of each screening. These group reflections provided an opportunity for participants to share observed changes they may have witnessed in themselves and their communities as a result of the intervention. The MSC approach is based on the collection of personal stories of change shared in these group reflections, an assessment of the stories by local stakeholders, and a selection of the stories of most significant change. Darts and Davies suggested a series of steps that can be adjusted to individual program aims and needs (12); the steps used for this project are described below.

Most Significant Change steps

Step 1 – Group discussions

The project team held a group discussion with all intervention participants at each of the 10 schools after the girls screened their first video. Here, they were asked to share observations of positive or negative changes they had seen or experienced after producing and showing the video to their peers. The project team took field notes.

Step 2 - Domain of change identification

Domains of change were used to organize participants' observations of significant change associated with the intervention. After reflecting on discussion field notes, the project team

identified four domains of change: 1) the participant's own behavior, 2) the behavior of their peers, 3) the behavior of their family, and 4) their communities or schools. In addition, an 'other' domain was used for all other observations of change.

Step 3 - Headline collection

The project team held a second round of group discussions with participants at each intervention school after their second videos were screened. With prompting found in **Supplemental Table 5.1,** participants reflected on significant changes observed in the outlined domains of change. These reflections were translated and transformed by the project team into one sentence "headlines" that captured the main observation (e.g., "*with participant's encouragement, family starts home garden*"). A total of 116 headlines were collected.

Step 4 - Selection rubric criteria

The project team developed a selection rubric based on the nutrition literacy levels to evaluate headlines (9). The rubric assessed the headline on four criteria: (i) an understanding and application of key nutrition information, (ii) an application of information to a new or different scenario, (iii) an attempt to address an obstacle or to influence a social determinant of health, and (iv) a long-term change at the community, school or household level. For each headline, the four criteria were scored as: does not demonstrate (0), somewhat demonstrates (1), or very much demonstrates (2); the final cumulative score ranged from zero to eight.

Step 5 - Headline selection

The project team categorized the 116 headlines into the domains of change and evaluated them using the selection rubric. Each criterion was discussed until consensus was reached. The three

headlines with the highest score in each of the four defined domains were identified. Two domains had a tie and both headlines were selected. The headline selection resulted in 14 headlines. Headlines that fell into the "other" domain were statements concerning a change in health outcome and were captured by the first four domains.

Step 6 - Story elaboration

The field staff conducted 14 in-depth interviews in Krobo with the participants whose headlines were selected. The interviewee was prompted (**Supplemental Table 5.2)** to elaborate on the details of the story, identify elements of the intervention that led to this change, and share why they thought this story was the most significant change. The interviews were translated and transcribed into English by project staff.

Step 7 - Story Writing

Two non-Ghanaian research assistants who were not previously involved in the intervention reviewed the interview transcripts and wrote a one-paragraph summary for each story. The summaries included: 1) what the situation was like before the change occurred, 2) what motivated the change, 3) the sequence of events, 4) challenges the participant faced and things that helped to facilitate change, and 5) why this change was significant. The project team reviewed the summaries and edited as needed to assure their accuracy.

Step 8 - Final Story Selection

The final selection was carried out by three of the CAB members; the PI facilitated the process. The 14 story summaries were read aloud by the PI, each was discussed in light of the selection rubric used previously for the headlines, and the CAB reached a consensus score for each story.

Then, the CAB members shared why they perceived a particular story was the most significant. The PI prompted them to reflect on the differences between stories and why similar stories may have received different scores. Such probing questions allowed for rich discussion about the underlying values held by the local stakeholders. The CAB then reviewed the scores given to stories within each domain and made adjustment to scores in light of their reflections. The story with the highest cumulative score within each domain was designated the most significant change story.

Secondary analysis

The PI conducted a hybrid reflexive thematic analysis of the 14 interview transcripts to further examine the participants' perceived influence of the intervention (15). The hybrid thematic analysis included a deductive analysis of themes outlined in the semi-structured interview guide (**Supplemental Table 5.2**). The questions provided a scaffold for expected themes such as how change occurred, barriers and facilitators for change, and why participants thought their stories were the most significant. An inductive analysis identified sub-themes that took shape naturally in the transcripts such as emerging patterns of action, attitudes, values, and motivation for change among participants. MaxQDA 2020 was used to conduct the thematic analysis. Results were presented to local project staff for member checking.

Results

A total of 181 adolescent girls, from the 10 intervention schools, provided informed assent and caregiver consent to participate in the trial (Figure 5.1). The average age of the 181 intervention participants were 14.3 ± 1.0 at recruitment. Sixteen percent of students (n = 29) were enrolled in

grade 4 to 6 in primary school and 84% (n = 152) were enrolled in junior high school in level 1 to 3. The Upper Manya Krobo district was primarily rural and underserviced. For example, only 49% of participants reported having electricity and only two adolescents reported having piped water in the home. The results of 1) the final selection of stories and 2) the secondary analysis are presented here.

Final selection of stories

The four most significant change stories and the reflections shared by the final selection CAB members are described below. A summary of the most significant change story per domain of change is provided in **Figure 5.2.**

Domain 1 – Change in the participants' own behavior

One story described how an adolescent accepted iron supplementation despite hearing false rumors of its adverse effects. The remaining two stories highlighted obstacles that the girls faced and overcame in acquiring healthy foods for themselves when family members did not accept or apply the nutrition information. The CAB members discussed the significance of the latter two stories, reflecting on nuanced differences in the girls' ability to address financial obstacles in a sustainable way. Both stories highlighted the participant's efforts to acquire and save money for healthy food: one adolescent helped her mother sell food at the market to collect money and the second adolescent helped her father to fish as well as made efforts to sell watermelon to save money. The CAB members explained that they valued the story that exemplified the girl's determination to find creative means to generate her own income without being reliant on other people. Her perseverance in the face of obstacles, creativity, and independence showed that she

understood and accepted the nutrition information. These were important reasons why this story was selected as the most significant story of change in participant behavior.

Domain 2 – Change in peer behavior

All three stories outlined how the participants 1) identified a peer who showed symptoms of anemia, 2) recognised its potential link to poor diet, and 3) taught their peer about healthy eating and its benefits. The CAB valued the adolescents' ability to persist, especially when those they were teaching had difficulty accepting the provided nutrition information. The CAB emphasized the importance of the perceived long-term effect of the story. The CAB highlighted the need for more than just changes in spending habits as this can be easily changed; one CAB member highlighted that *"they will take this information for some weeks, after some weeks they will reverse back"* (CAB member 1). The MSC story on peer's behavior described how the adolescent's neighbor acknowledged the importance of iron-rich foods and hired more fishermen to their business to increase their yield of fish for the family.

Domain 3 – Change in the family behavior

Two stories depicted how the participants convinced parents of the benefits of eating balanced meals and iron-rich food. This resulted in changes in the family's spending habits, meal preparation, and consumption. The third story described how a participant encouraged her family to start a home garden in response to the perceived lack of a variety of food. The fourth story described how a participant talked to her father about changing the agricultural practice of spraying iron-rich foods like kontomire (*Xanthosoma sagittifolium*) with weedicide and offered to help weed around them instead. There was an initial tie among the latter two stories. To break the tie, the CAB emphasized the need to

contextualize the stories in order to judge their merit. What ensued was a discussion about the underlying issues related to local agricultural practices. The CAB members reflected on discussions they have had with community members, and common agricultural practices they have witnessed to identify whether the lack of home gardens or the practice of spraying was the most prevalent issue. The CAB acknowledged that it would be difficult to convince the community to sustain home gardens despite its benefits *"what [the community] understand[s] is that the kontomire is still on their farms, so why will they make a garden? So, whether they have a garden or not, still we have those vegetables [in the farm] and we have to make use of them. Now the one challenge is that there is method of spraying – you are spraying the vegetables,"* (CAB member 2). The value of the story was finally determined by reflecting on the implications of the story becoming common practice. The most significant change story in family behavior was the newly adopted practice of weeding rather than spraying iron-rich foods. It addressed the most prevalent local agricultural issue and would have the greatest impact on others - if they too would adopt this behavior.

Domain 4 – Change in community or school

All four stories described an increase in fruits or iron-rich foods provided in the participants' school canteens. Due to the similarities in the story outcomes, the CAB evaluated the means taken to promote change. In three stories, participants approached current or potential canteen women to teach them about the need to diversify the food offered. In the fourth story, participants showed their video about the need for balanced meals at the canteen to their headmaster, who then approached the canteen women himself. The CAB saw merit in the

participants' ability to draw on influential people to help generate change. One CAB member described that this approach was wise because *"normally the teachers and the head have influence on the canteen,"* (CAB member 1). Others argued that change would be more sustainable when the canteen women were taught the nutrition information themselves, saying that *"this will go a long way, because the canteen women have [understood] the whole thing,"* (CAB member 3).

All agreed that the change in food provided in the canteens was praiseworthy as it increased the supply of healthy options. To determine the most sustainable approach, focus shifted towards stories that showed changes in the demand for healthier canteen food. They reasoned that if the students themselves understood and accepted the nutritional information about balanced diet, there would be a long-term demand for healthier options at the canteens which would drive the supply. They argued that although some stories described a larger change in the types of foods provided at their canteens, the students themselves did not appear to understand the nutrition information and were rather profiting from the changes in the canteen without understanding the benefits. They claimed that although the adolescents would benefit indirectly, *"they should have the information, [and] know that […] what I'm doing [is] right,"* (CAB member 2). The most significant change story was the story that demonstrated that the students themselves understood the nutritional information and that this was manifested in an increased demand for fruits instead of sweets at the canteen.

Thematic analysis results

The following are the results of the inductive thematic analysis of the interviews with adolescent girls whose headlines were selected. Interviews explored adolescents' patterns in motivations to spearhead change, their capacities for action, the barriers and facilitators to change, and why they deemed their story to be the most significant.

Motivation

Adolescents were primarily motivated to influence health outcomes. Of common concern was the ill health they and their peers faced – anemia, menstrual pain and irregular flow, frequent sickness, fatigue, feeling "dull", and being inactive. One participant explained that *"what motivated me is that my sisters always feel sick […] so I was happy to help my father to weed around the kontomire so that we get the leaves and eat always to avoid the shortage of blood [anemia] in our family,"* (15 y old, Junior High School (JHS) level 1). Aside from the desire to address poor health, many adolescents described a motivation to be healthier, grow faster, and to look "fat" with "sparkly" skin - *"what motivated me was that when we eat such foods, we will be fat and we will be healthy. That motivated me to bring the change to the house,"* (16 y old, JHS level 2).

A prominent motivator was the desire to test the nutrition information for themselves. Stories of change often started by adolescents critically appraising the validity of the nutritional claims and judge its value. For example, one adolescent said *"the first time that I received this education I thought it's not anything serious because my grandmother used to eat those things. So, the first thing I do is to practice it myself to see whether it is true or not."* (13 y old, JHS level 1). Another great motivation was a concern for the well-being of others and a sense of

responsibility to share their newfound knowledge. One adolescent explained that *"I learned that what we learn we should not keep it to ourselves alone but we should teach others to help bring change for all of us."* (16 y old, JHS level 2).

Capacities for action

The stories of change demonstrated that the adolescents often took a three-step approach: 1) identify the problem, 2) practice the nutrition education themselves and evaluate its validity, and 3) make a game plan to teach others. Interviewed adolescents demonstrated the capacity to identify symptoms of ill health and link them to poor diet. Many shared how they initially practiced the nutrition information for themselves to generate proof and to *"[see] if it was good"* (14 y old, JHS level 1). Participants shared how they needed to be thoughtful in the way that they taught their parents and those in higher authority like school staff. What the adolescents commonly communicated to their respective audiences - peers, family members, neighbors, and school staff – was their understanding of the nutrition information they were taught, why they thought it was important to adopt new dietary habits, and their assessment of the important issues they faced.

Barriers and facilitators to change

The most common challenge was resistance adolescents met from parents and other elders to the nutrition information they were teaching. Other obstacles included overcoming shyness and a lack of resources (e.g., seeds, money) needed to practice what was taught. The adolescents were able to overcome obstacles and create change by identifying their strengths such as building off of relationships of trust they had in their families and communities, an important facilitator. An adolescent explained how her sibling's encouragement and support motivated her to persevere in

approaching their father, *"the day you came to educate us on it and I went home; I went [to] organize my younger siblings who are in the primary [school] and I made them sit as we use to sit down. I became the teacher and started teaching them on things to eat. I told one of [my sisters that] my father doesn't want to listen to me when I ask him to eat turkey berry and she encouraged me to say it more. I also continue to say it. Now if we want to cook; he will ask us to add it to the food."* (15 y old, JHS level 2) The adolescents were able to promote change because the people that they were teaching trusted them and their intentions. An adolescent shared how her neighbor told her that *"when [my neighbor] went to the hospital, she was told to eat these things, but she didn't believe, but because I have come to tell her, she believes me and she will do as I say,"* (16 y old, JHS level 1).

They were encouraged to continue teaching others because of their confidence in the validity of the nutrition information and its potential to stimulate change, the social support and encouragement they received from their peers and parents, and the adoption of new behaviors around them. An adolescent shared how she and other intervention participants supported each other in promoting change. She described how, *"when they came to teach us, we all went to practice and saw how it was. When we came to the school I told [my friends that] I went to practice it and it is good and I have seen a change. [My friend] also came to tell us she has seen a change. [Two other friends] came to tell us the same thing then we said since [other students] haven't practiced it yet; we will go and talk to the canteen women so that they change the food." (14 y old, JHS level 1)*

Perceived significance

Adolescent interviewees were asked to share their reflections as to why their respective stories were the most significant. The common response was to judge the merit of the story by reflecting on the health outcomes seen in themselves, families, and peers. It was often argued that the story was significant because they had observed more regular menstrual flow, less menstrual pain, felt healthier and more active, or better retained what was taught in class. One participant explained, *"the important change story was that none of my family members fall sick again, no more shortage of blood [anemia] in the family again and everyone is healthy in the family, that is the most important story for me in this intervention,"* (15 y old, JHS level 1). Appearance was also a valued indicator of change. They prided themselves in their ability to gain weight and have radiant skin.

Intervention activities attributed to change

Adolescent interviewees were asked to identify the aspects of the intervention that had the most influence on change. Some referred to the new nutrition information they learned through the lessons. The process of discussing with their peers about the topic and content of the videos they were producing was particularly important to change as it facilitated understanding and a desire to teach. What stood out to the youth was the moments where they were able to have meaningful conversations with their peers in preparation for the educational video. Many said that the Margolis Wheel activity made them 1) feel comfortable to ask questions, 2) retain the nutrition information they were taught, 3) comprehend new components of the lesson they previously did not understand, 4) discuss its application in their lives, and 5) consult and identify the most pressing obstacles. An adolescent highlighted how, *"there are some things that we don't know*

and if [the teacher] asks questions […] we [feel] shy to ask, but with [this activity] we can ask our friends and we can open up more to discuss with our friends," (13 y old, JHS level 1). They explained how these discussions helped them understand the material and build confidence to teach others. One adolescent said, *"it made me become a teacher to teach others. I like that,"* (15 y old, JHS level 2) and another highlighted that *"it help[s] us to understand the lesson because we explain it to our friends,"* (13 y old, JHS level 1). Few adolescents referenced the act of filming and sharing of the video as being the most important activity that motivated change.

Discussion

This study presented evidence that participatory video nutrition education promoted a transformative change; participants modified their eating habits, lifestyle, and their environment. This is the first study to evaluate 1) the influence of a PV nutrition education intervention on adolescent participants' critical nutrition literacy and behavior, and 2) the perceived impact of the intervention on participants and local stakeholders. It is also the first study of a PV nutrition intervention with adolescent creators.

Though PV has been practiced in community development since the 1960s, it has only been regularly used in nutrition promotion by SPRING since 2012 (11). Research on the use of PV as an approach for nutrition promotion is fairly new. Published studies focus on cultural acceptability and effectiveness of information uptake and personal behavior change when nutrition-sensitive information is shared though a PV medium. For example, a mixed-methods study in India showed how PVs were widely accepted and became an important source of nutrition information in communities, and increased handwashing and responsive feeding among

PV audiences (16). Another mixed-methods study was conducted in Niger and Burkina Faso that promoted maternal, infant, and young child nutrition and hygiene practices through PV screenings in community gatherings (17, 18). The researchers reported that watching the PVs increased knowledge, self-efficacy and behavior changes related to handwashing and feeding practices (17, 18). Nutrition research has focused on the audience that watches the participatory videos rather than those who produced them - this is where our study differs.

There was no published research highlighting the impact of participating in the PV-making process on nutrition behavior change, the focus of this study. The results of two studies showed the important role of participatory activities in amplifying the influence of PVs. Cai et al. (19) looked at the influence of locally-made nutrition videos on audience members' knowledge and behavior in comparison to a more participatory live food demonstration. Their results showed that although watching a PV increased knowledge, it did not improve change in nutrition behavior as much as live demonstrations (19). Kadiyala et al. (20) evaluated three nutrition-sensitive agriculture (NSA) interventions in a four-arm cluster-randomized controlled trial in rural India on maternal and child dietary outcomes. The intervention arms included women's group meetings as well as 1) NSA videos, 2) NSA and nutrition-specific videos and 3) NSA and nutrition-specific videos, and participatory activities. The two groups that included nutrition-specific videos showed a significant difference in meeting child minimum diet diversity and maternal diet diversity (19% and 27%, respectively) compared to control groups (20). The intervention arm with participatory activities was most influential on participant behavior, suggesting that the participatory nature of this intervention arm may be an important element that can help amplify the influence of a PV intervention (20). Further research is thus necessary to better understand the influence of PV interventions that emphasize active participation.

The concept of critical nutrition literacy is associated with cognitive and social skills to 1) think critically about the merit and application of nutrition information and to implement change in personal nutrition behavior and lifestyle, and 2) to exercise one's agency to address obstacles to behavior change through increased engagement in social action (8). Our results are consistent with research highlighting the influence of PV on participants' personal behavior - the first component of critical nutrition literacy (16, 17, 18, 19, 20, 21). There are no published studies on the influence of a PV nutrition intervention on participants' engagement in social action - the second component of critical nutrition literacy. There were, however, two studies in rural India that monitored how PV audiences taught others about nutrition messages promoted in the videos (16, 21). Though the researchers detected a nascent capacity among PV audiences to teach others, they concluded that information sharing was limited (21). The focus of these studies was the degree of diffusion of the message; they did not monitor the resulting change in behavior among their social networks. Our study contributes unique evidence on the capacities of adolescents to diffuse learned messages and contribute to behavior and structural changes in their communities. Although there is little research on this topic, Kadiyala et al. (21) acknowledge that "*the ultimate impact of the intervention will depend on the effectiveness of group members to diffuse key messages to stimulate social change*". This paper begins to contribute to this particular branch of PV nutrition education research – one that looks at the influence of nutrition PVs on social action and environmental change – and opens avenues for new research questions and explorations.

Intervention activities attributed to change

The aim of this study was to investigate the influence and value of the participatory video-making process. This process involved a series of activities: peer discussion to develop the content of the videos, filming, screening videos, and reflecting with their peers about their efforts to bring about change. The interviewees did not refer to the act of filming as the most influential intervention activity that promoted change, rather they highlighted the Margolis Wheel and Problem Tree activities. These activities were foundational in developing the content of the videos. They were designed to help adolescents reflect together on the application of the nutrition information as well as the social and environmental factors that might impede its implementation. Their positive feedback to these exercises supports the premise that adolescents respond well to the opportunity to think critically about factors that affect their lives and the lives of their communities, and to propose creative solutions. These two activities were done within the context of a participatory video intervention – where the adolescents were aware that they were participating in a series of activities that would help them produce an educational video for the purpose of promoting change. Our study would not be able to suggest that these two activities in isolation would produce the same transformative results – additional research is needed to clarify that claim.

Perceived value of the intervention

The MSC method helped us examine the influence and value of the intervention from the perspective of the participants and local stakeholders. This method revealed differences in the value systems of the adolescents and local stakeholders who judged the merit of stories. The interviewed adolescents commonly expressed that a positive health outcome was the reason why

a story was the most significant. In contrast, the CAB valued how change occurred, the manner in which a change was put into place, the relevance of the issues it tackled, the capacities manifested, and its perceived sustainability. Though these values are not mutually exclusive, it does reflect a difference in value systems between youth and the adult CAB members. Using an MSC method, which included the participation of both youth and adults, strengthened the evaluation of the intervention because it incorporated multiple perspectives. Additionally, the difference in value systems reinforces the importance of having youth's point of view adequately represented in research relevant to their lives (3). The voice of youth can be incorporated in simple ways. A selection rubric can be developed with a wider range of local collaborators which includes youth participants. Alternatively, future projects can ensure that youth are invited to be active members of the CAB such that they have more ownership in the design, implementation, and evaluation of interventions.

Limitations

Despite the benefits of the MSC method, there are limitations due to elements of its implementation. In this application of MSC, headlines were collected at one time point therefore changes over time were not captured. The headlines were also collected soon after the screening of their second video therefore more long-term changes were not recorded. Ideally, headlines would be collected at more than one occasion with ample time in between to capture a range of changes. The nature of the MSC method is to seek out and record stories of change, whether positive or negative, giving rise to a results bias (22). Another element of MSC method is the limited generalizability of its results. Its results help us appreciate the nuanced values and influence of the intervention in its unique communities and context.

Conclusion

This study contributes to the burgeoning body of research on the positive influence of PV nutrition education on knowledge and behavior. Research has focused on the influence of sharing nutrition information through a PV medium. This study, however, highlights the transformative influence of the PV-making process on addressing local nutrition issues, and empowering adolescent participants to change their own dietary habits and the environmental factors that support healthy lifestyles. Adolescents identified the PV activities that encouraged participatory peer reflection as an essential component of the intervention that influenced change. The MSC approach facilitated the evaluation of this complex behavior change intervention, as it highlighted the important personal and societal changes that resonated to adolescent participants and local stakeholders. Interventions that engage youth in the design and implementation of research facilitate the empowerment of adolescents and contribute to a myriad of changes. What is needed are creative means to involve adolescents in the design, implementation, and evaluation of programs that are meant to serve them.

Acknowledgments

We gratefully acknowledge the valuable contributions of the adolescent girls that participated in making educational nutrition videos to promote change, the guidance of our Community Advisory Board, as well as the tireless work of our project staff: Mary Sackitey Sackie, Regina Mamle Tettey, Florence Teye, and Grace Nyumu-Teye.

Statement of authors' contributions to manuscript

MZG was responsible for the design, implementation, analysis, interpretation, and writing.

GSM, NDD, NA contributed to the design and interpretation.

All authors read and approved the final manuscript.

Data sharing

Data described in the manuscript, code book, and analytic code will be made available upon request pending application to the corresponding author (MZG) and approval.

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Figure legend

Figure 5.1 – Study participant flow diagram in a cluster randomized controlled trial evaluating the effectiveness of a participatory video nutrition education intervention among adolescent girls in rural Ghana

Figure 5.2 – Results of a Most Significant Change evaluation of a participatory video nutrition education intervention with rural Ghanaian adolescent girls, 13-16 years of age: headlines selected for elaboration and corresponding most significant change story per domain of change

Supplemental table legend

Supplemental Table 5.1 – Most Significant Change method – group discussion questions for headline collection

Supplemental Table 5.2 – Most Significant Change method – in-depth interview questions

Figure 5.1 – Study participant flow diagram in a cluster randomized controlled trial evaluating the effectiveness of a participatory video nutrition education intervention among adolescent girls in rural Ghana

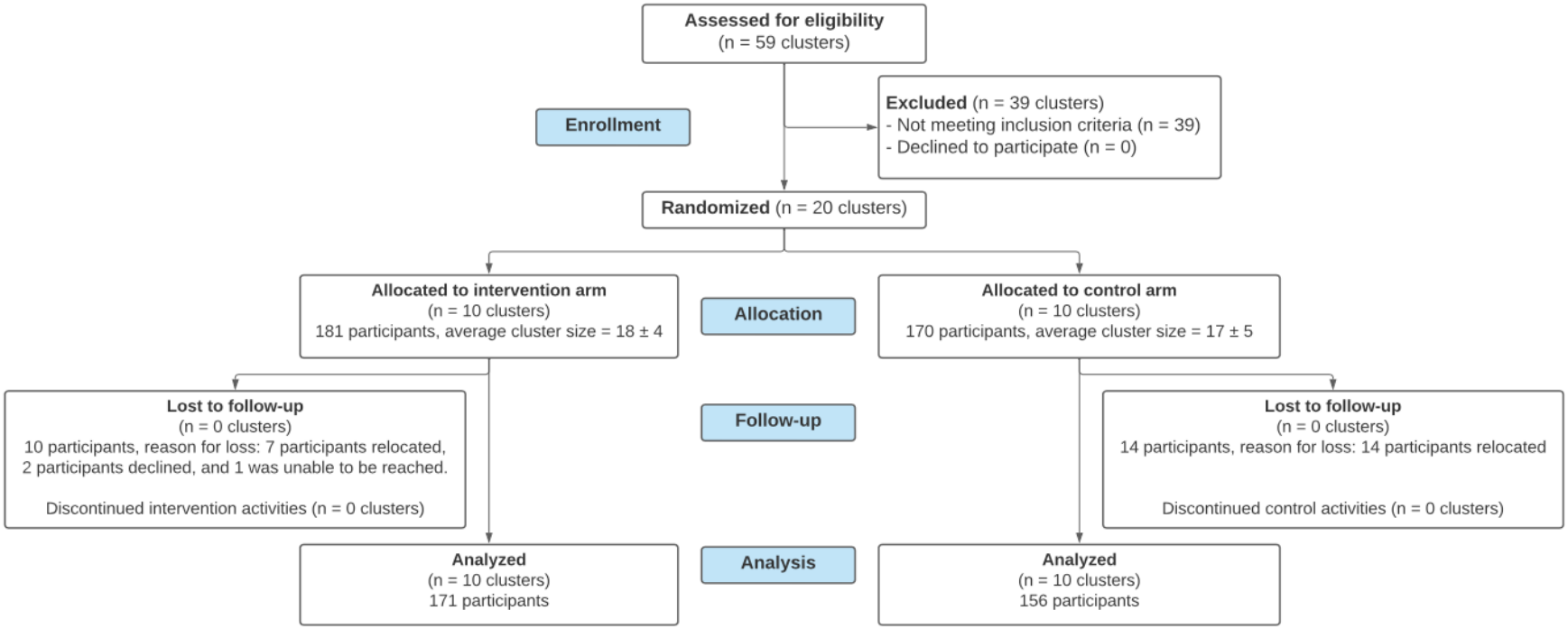
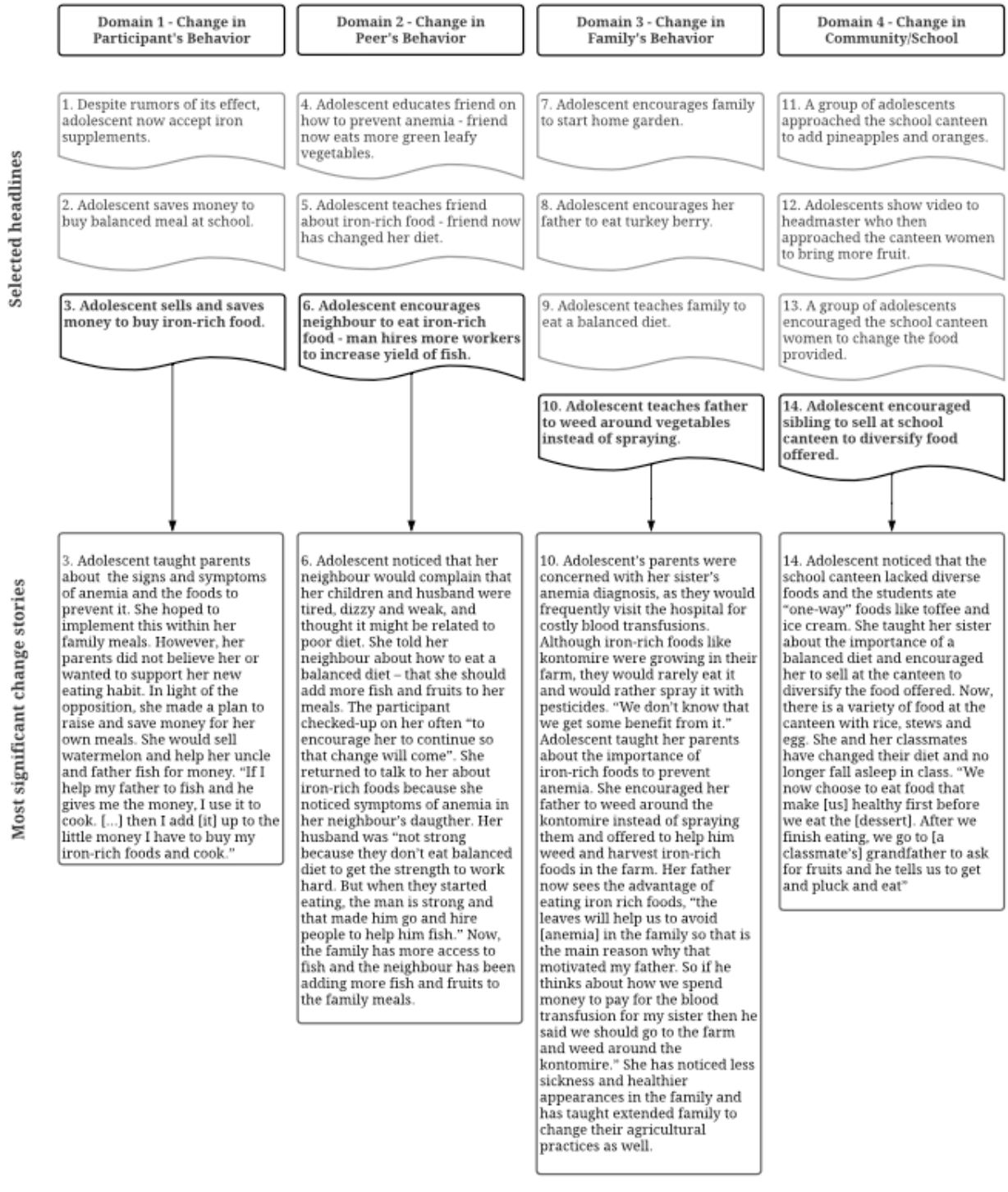


Figure 5.2 – Results of a Most Significant Change evaluation of a participatory video nutrition education intervention with rural Ghanaian adolescent girls, 13-16 years of age: headlines selected for elaboration and corresponding most significant change story per domain of change



Supplemental Table 5.1 – Most Significant Change method – group discussion questions for headline collection

Questions asked to group of participants	Purpose of question
What positive or negative changes have you observed since our last video screening?	To record a range of positive and negative changes observed by the participants without any prompts.
What is the most significant change you have seen in your own behaviour, if any? What is the most significant change you have seen in the behaviour of your peers, if any? What is the most significant change you have seen in the behaviour of your families, if any? What is the most significant change you have seen in your schools or communities, if any?	To record what the participants deemed the most significant change in each of the domains of change. To identify their perception of the most significant change in 1) their own individual behaviour, 2) their peers' behaviour, 3) their family's behaviour, 4) the community, school, and surrounding environment.
Are there any other significant changes you have observed as a result of your participation in this intervention?	To record any additional significant changes experienced.

Supplemental Table 5.2 – Most Significant Change method – in-depth interview questions

Questions asked to adolescent participant of selected headline	**Purpose of question**
You had mentioned an observation about *(refer to their selected headline)* during our group reflection. Is this correct? Can you tell me more about that story?	To give the participant the opportunity to speak about the story unprompted. To give opportunity for the interviewee to mention elements of the story that seemed worth sharing.
What was it like before the change occurred?	To understand circumstances prior to change occurring.
What were the different steps that helped the change occur?	To understand how change occurred.
What motivated you to make this change? What do you think started this change?	To identify why the change occurred.
What helped you put the things you learned into practice? Was there anything hard about putting this into practice? If so, what? What helped you get over this challenge?	To identify what facilitators or barriers the participant faced in order to incite change.
What does it look like now?	To better understand the magnitude of change.
Why do you think this is the most significant change story?	To understand what changes are the most highly valued and why.

CHAPTER VI. Discussion

Addressing research gaps

This dissertation sought to understand how CNL can be enhanced in adolescents and how improved CNL can influence behaviour. Specifically, it aimed to examine the research gaps outlined in the CNL framework in Figure 1.1: 1) what nutrition education intervention can improve CNL among adolescents, and 2) does improved CNL influence personal behaviour, engagement in social action, and nutrition outcomes? A participatory video-making intervention was designed and a cluster randomized controlled trial was conducted to answer this line of inquiry.

Recent studies on participatory video nutrition education have focused on the influence of watching participatory videos on audiences' food knowledge and dietary behaviours but have yet to look at the influence of the participatory video-making process on video creators. The first study tested the effectiveness of a participatory video-making intervention on adolescent video creators' CNL indicators as well as functional and interactive nutrition literacy, personal food choices, and dietary intake. Exposure to the participatory video intervention led to a 4-fold increase in critical nutrition literacy (AOR= 4.24; 95% CI: 2.02, 8.87). There were also significant differences in interactive nutrition literacy (AOR= 5.52; 95% CI: 2.21, 13.78) and functional nutrition literacy (AOR= 2.14; 95% CI: 1.05, 4.33). Results show significant group differences in knowledge about balanced diet (AOR= 7.31; 95% CI: 2.38, 22.50) and iron-rich food (AOR= 6.44; 95% CI: 1.21, 34.38). Moreover, when asked about their food choice when purchasing a meal for themselves, intervention participants chose more balanced (AOR= 8.92;

95% CI: 1.49, 53.48) and iron-rich meals (AOR= 11.77; 95% CI: 2.32, 59.78). There were no group differences in daily food consumption of dark-green leafy vegetables, meat, and fish. This is the first reported trial, that we are aware of, that investigated the influence of a participatory video-making intervention on the nutrition literacy of youth creators.

There is a lack of data about the individual and environmental factors that influence adolescent diet in rural Ghana. In the intervention, adolescents formed cognitive maps of the challenges they faced to get a balanced diet and iron-rich food and made a video examining the most pressing challenge for each. The second study examined these cognitive maps and videos to better understand the nutritional challenges adolescent girls faced in rural Ghana. This analysis showed that adolescents' agency was limited by their lack of decision-making power at home and purchasing power at school. When they could make their own food choices, their decisions were influenced by their lack of nutrition knowledge and preferences and limited availability of animal-sourced foods, fruits, and dark green leafy vegetables. The availability of these nutrient-rich foods was shaped by the knowledge and priorities of gatekeepers of adolescent diet - parents at home and canteen staff at school. For example, common family agricultural practices of cutting down and spraying dark green leafy vegetables with weedicide negatively affected the availability of iron-rich food in the home. These results contribute to our understanding of adolescent food environments and their perceived influence on adolescent diet.

The third study collected and selected stories of change, reported by the intervention participants, to better understand the breadth and depth of the intervention's influence on participants' behaviour and their environment. This study presented evidence that participatory

video nutrition education promoted a transformative change; participants modified their eating habits, lifestyle, and their environment. This study provides further evidence of the influence of a participatory video intervention on participants' behaviour – specifically their increased engagement in social action – and in the behaviour of their peers, families, and schools. This is the first study to evaluate 1) the influence of a PV nutrition education intervention on adolescent participants' critical nutrition literacy and behaviour, and 2) the perceived impact of the intervention on participants and local stakeholders. It is also the first study of a PV nutrition intervention with adolescent creators.

This dissertation provided evidence of the added value of a participatory video-making intervention in nutrition education among adolescents. The participatory video-making intervention provided a framework for adolescents to improve critical nutrition literacy, food knowledge, and food choices. Intervention participants explored their diet-related challenges and devised solutions. Finally, they were inspired to act and teach others for the betterment of their peers, families, and communities. In so doing, the participatory video-making nutrition education intervention provided a viable model for adolescent girls to enhance critical nutrition literacy and to be agents of change in their community. The following is a reflection on the dissertation's evidence on how a participatory video-making nutrition education model 1) nurtured CNL among adolescent video creators, 2) influenced behaviours related to increased CNL, but 3) had no influence on adolescent diet. It also explores the implications of the studies' results on future areas of research in CNL, behaviour change, and adolescent diet as well as implications for program development.

Nurturing critical nutrition literacy

To understand how to influence CNL among adolescents, a participatory video-making intervention was designed. The intervention activities were adapted from activities promoted by *InsightShare,* a non-profit organization located in Oxford, United Kingdom and were inspired by the defining characteristics of CNL – the confidence and capacity to think critically about nutrition information and to act upon this information by changing personal behaviours and their surrounding environment (Lunch & Lunch, 2006). The *Margolis wheel* activity gave adolescents the opportunity to talk to their peers, one-on-one, about their understanding of nutrition information and reflect on environmental factors and social determinants of health that may impede its application. The *problem tree* activity gave adolescents the space to articulate the range of nutritional challenges faced, consult together, and identify the most pressing challenge. The *storyboarding* activity allowed them to envision a new narrative – one where their proposed solution could be implemented and where they redefined themselves as agents of change in their community. Finally, the *screening* activities provided a framework for action where they could share their educational videos and begin to have conversations with other classmates and school teachers to promote change. Manuscript 1 provided evidence that these participatory video-making intervention activities were successful in improving CNL among adolescents. This study is unique. The only other published study that looked at CNL promotion was among highly educated nutrition college students in an industrialized country (Bedoyan et al., 2019) – a demographic that might not be generalizable to the majority of adolescents across the world. This pilot trial provided a clear footing from which we can continue to examine the influence of nutrition education models on CNL among adolescents.

Although not commonly used in nutrition, participatory video-making has been used in community development, education, and advocacy since the 1960s, and has been adapted for use in participatory research (Granger et al., 2018; Kindon, 2003; Koningstein & Azadegan, 2021; Servaes, 1996). The participatory video-making process involves analytical exercises to reflect on participants' lived experiences and varied perspectives, to reimagine what can be done, and to articulate the approaches needed to bring about transformative change through the use of the arts. It allows participants to write a new narrative and to self-represent their thoughts and identities as "active citizens" (Rodríguez & Brown, 2009). The main difference between conventional and participatory video interventions is the power dynamics between researchers and the local population (Koningstein & Azadegan, 2021). A participatory video approach values mutual learning and contributes to a more equitable power dynamic between researchers and local populations by emphasizing participants' knowledge and agency. Freire advocated for educational models along those lines – education that values local knowledge, and invites interaction, critical analysis, and participation to promote transformative learning and critical consciousness (Freire, 1970). Drawing on Freire's construct of critical consciousness, the intervention helped local participants develop knowledge and skills to identify and tackle nutritional challenges and refine their investigative critical-thinking and problem-solving skills (Freire, 1974). Nutbeam suggested that education that raises awareness of socio-economic, cultural, and environmental determinants of health may also be key to literacy and agency (Nutbeam, 2000). Studies have shown that participatory video-making has influenced critical thinking, communication and collaborative skills, and agency among youth creators that addressed climate change in circumpolar Canada (Petrasek MacDonald et al., 2015), natural

disaster risk reduction in the Philippines (Haynes & Tanner, 2015), menstrual hygiene in Nepal (Ghimire & Devkota, 2020), and the safety of school environments in South Africa (De Lange & Geldenhuys, 2012).

Behaviours related to critical nutrition literacy

In the proposed framework, CNL is manifested in two main ways: 1) a change in personal dietary behaviours and 2) increased engagement in social action to change influential environmental factors. Manuscript 1 provided evidence that an intervention that improved CNL also had a significant effect on adolescents' food choices when purchasing a meal for themselves. Manuscript 3 provided additional evidence of the intervention's influence on personal eating habits and lifestyle changes. Stories of change described how adolescents purchased more balanced and iron-rich meals for themselves and how they found creative means to earn and save money to afford such meals. Stories of change also described how adolescents engaged in social action and influenced their peers, families, and schools. They taught their peers and families about healthier eating habits, helped them identify environmental obstacles they faced, and worked alongside them to implement solutions. This is seen in the stories of peers and families adopting new farming techniques, business decisions, and market practices. Finally, adolescents advocated for changes to the food in school canteens to provide healthier options for their classmates. Manuscript 1 and 3 therefore provided evidence that the intervention improved CNL-related behaviours – personal dietary practices and increased engagement in social action.

In addition to answering the primary research questions – does a participatory-video making intervention influence CNL and its related behaviours among adolescent video creators – this dissertation began to shed light on future areas of research. These topics are explored below.

For example, the interviews with the adolescent girls in Manuscript 3 also provided vital information about how the girls brought about change – specifically, they shared about the sequence of actions they took, the related capacities and attitudes they embodied, the facilitators and barriers they encountered, and the elements of the intervention that helped motivate change. Though this was not part of the primary goals of the dissertation, this information helped shed light on the potential pathway and mediating factors between increased CNL and behaviour change. These studies also allow us to start to consider implications of CNL at the community level because a high percentage of adolescent girls became critically nutrition literate in the intervention communities. Although Manuscript 3 provided evidence of behaviour change, there was no significant difference in adolescent diet. Manuscript 2 described the barriers and influential factors in the adolescents' food environments and highlighted the important role of caregivers as gatekeepers of adolescent diet. The following section is a reflection on the implications of the studies beyond the initial research questions.

Implications for future research – critical nutrition literacy behaviour change pathway

The interviews with intervention participants in Manuscript 3 shed light on how the intervention promoted critical competencies inherent in CNL. In the interviews, adolescents from the intervention arm described testing the validity of the nutrition information they were taught by practicing it themselves to see if the nutrition information was true. They mentioned that this search for truth was an important initial step before deciding to teach others. This capacity to critically appraise nutrition information is inherent in CNL (Nutbeam, 2000). Adolescents then assessed their environment, identified the obstacle that impeded them from practicing a new dietary behaviour, and planned to teach others to promote change. These results also help us

begin to understand a potential pathway through which increased CNL can influence behaviour. This is important as it can help us understand the underlying dynamics of behaviour change and identify future points of intervention. It helps highlight capacities that should be a focus of future CNL interventions. For example, to address environmental challenges, the adolescents needed to better understand the social and environmental factors that influenced their nutrition and dietary behaviours. The interventionincluded activities that allowed for this understanding to unfold. Additional research is needed to better understand this pathway and to investigate how to influence it.

Implications for future research – critical nutrition literacy at the community level

The proposed framework in Figure 1.1 implied that improved CNL may have important implications at the population level. Nutbeam suggested that enhanced critical literacy among a greater proportion of the population will have community-level social and health benefits (Nutbeam, 2000). Enhanced competencies to understand and address environmental challenges to nutritional issues among a wider set of the population may catalyze socio-economic and cultural shifts and foster effective community action to promote nutrition. Results from Manuscript 1 described how 85% (145/171) of adolescent girls in intervention schools were critically nutrition literate at endline compared to 60% (93/156) in the control arm. I assumed that if a greater proportion of a community's adolescent population became critically nutrition literate – that they had the confidence, capacity, and willpower to promote change in their personal lifestyles and community life – that there would be the initial glimmerings of cultural shifts and collective action. In Manuscript 3, stories described changes in adolescent, peer, and

family behaviour that began to challenge established socio-economic and cultural constructs. For example, there was a shift in the economic demand for foods such as kontomire in their homes, school canteens, and community markets. Stories described how adolescents approached school administration and canteen staff to advocate for more iron-rich options. Other stories described families changing agricultural practices by not spraying kontomire with weedicide, seeking out iron-rich plants in markets, or travelling great distances to purchase seedlings to plant in home gardens. Such stories triggered the need to engage district institutions like the Ministry of Food and Agriculture to increase the supply of agricultural resources and seedlings. This doctoral research provided a glimpse into the initial stirrings of cultural and socio-economic change in communities where more and more adolescents are critically nutrition literate. In doing so, it underscores the added value of a participatory video-making intervention in nutrition education in catalyzing social and environmental change. In addition, no studies have examined the influence of improved CNL at the population level, especially among youth. The results of this doctoral research suggest the need to further explore the influence of enhanced CNL at the community level and its influence on culture and other social determinants of health.

Implications for future research and program development - influence on adolescent diet

Manuscript 1 and 3 presented different pictures of the intervention's influence on adolescent diet. Data from Manuscript 1 suggested that there were no differences in daily intake of Grow or Glow food groups or iron-rich foods. Manuscript 3, however, collected stories of adolescents changing their eating habits and their daily food consumption of balanced and iron-rich meals. This methodology did not have any comparison to participants in the control arm – a comparison necessary to make a statement of the intervention's influence on adolescent diet. Additional

research with more sensitive dietary assessment tools may help better understand changes in dietary intake. A non-quantitative food frequency questionnaire was used to assess food group consumption in study 1. Repeated quantitative 24-hour food recalls have been a more sensitive dietary assessment approach that could have detected subtle differences in dietary intake. Research may also be needed to further explore why, in Manuscript 1, there were significant changes in adolescent food choices when purchasing meals for themselves, but no change in dietary intake. Self-purchased meals did not make up a large portion of the participants' diet. In the baseline surveys, adolescent girls reported purchasing only 4.4 ± 4 meals for themselves during the previous week. Manuscript 2 also brought attention to the limited purchasing power adolescent girls have at school canteens and community kiosks, and the poor decision-making power they have at home. This may be an important part of the puzzle. However, additional research is needed to understand the limitations in adolescent girls' agency and decision-making power and how it influences dietary intake.

Manuscript 2 provided vital information about adolescent girls' challenges in getting a balanced diet and iron-rich foods. One of these challenges was a lack of knowledge about nutrition information and the implications of eating more nutritious meals. The nutrition curriculum that was provided to the girls' clubs directly addressed this challenge when it provided adolescents with nutrition information and tools to choose balanced meals and iron-rich foods. However, a range of other challenges remained present that the intervention did not directly address – challenges in availability and access, and the lack of knowledge among their peers, families, and school canteens. Manuscript 3 described how adolescents in the intervention were actively trying to overcome these challenges by teaching others, changing their household

agricultural practices, or advocating for change in their schools. It is important to note that the endline surveys – where we assessed CNL, food choices, and dietary intake – were completed soon after the intervention was completed. This might not have given the adolescents ample time to overcome the challenges they faced in changing their diet. If this research were to be repeated, it would be recommended to give more time between the end of the intervention and the beginning of endline data collection.

Implications for future research and program development - gatekeepers of adolescent diet

Manuscript 2 also described the influential role of gatekeepers in shaping adolescent diet. One of the key barriers to balanced meals and an iron-rich diet was the limited availability of nutrient-rich food. Adolescents described how the availability of such food was shaped by the knowledge and priorities of gatekeepers – caregivers at home and canteen staff at school. This has practical implications for the design and implementation of future adolescent interventions. It would be important to involve caregivers and school staff in adolescent interventions as they remain key influencers of adolescent diet.

One way to include parents in a participatory video intervention is to include a plan for adolescents to screen their videos with their parents and communities. Video screenings can foster meaningful and action-oriented discussions about strategies to improve adolescent diet and allow parents to benefit from the nutrition information. Screenings were held as part of the knowledge mobilization plan after completing data collection activities. There are ample studies that show that a nutrition education intervention that uses a participatory video medium is an acceptable behaviour change communication tool in rural developing settings and has changed nutrition knowledge and behaviour (Cai et al., 2015; Dougherty et al., 2016; Harou et al., 2017;

Kadiyala et al., 2021). This dissertation intended to examine the video-making process, not the influence of disseminating the produced participatory videos. If the cluster randomized controlled trial was repeated with an intention to evaluate the influence of the participatory video-making and the screening of videos with key gatekeepers of adolescent diet, nutrition literacy, food choice, and dietary intake should be measured at baseline, at a midline point after adolescents made participatory videos, and then at the endline after sharing videos with parents and school staff.

Implications for research methodology – a participatory research model

Manuscript 2 also provided evidence that a participatory video methodology can be used within the context of a participatory research paradigm. Adolescents were willing to serve as local co-researchers – drawing from their intimate understanding of the nutrition issues under investigation. The research exposed a range of challenges to getting a balanced diet and iron-rich food – information that is vital to shaping future nutrition-related policies and programs. For example, Manuscript 2 highlighted specific caregiver behaviours – poor farming techniques and market practices – that influenced the availability of nutrient- and iron-rich food at home. In Manuscript 3, the CAB confirmed that the farming practice of spraying and cutting-down iron-rich plants was a common habit in the district. They chose a story of change that addressed this issue as the most significant change story in its domain because of its transformative potential to change agricultural production in their community. In this traditional food environment, the supply chain is greatly influenced by local production from a network of villages. The decisions that small-scale farmers make about production and market sales influence the choices that are available for the diets of their and their neighbours' households and the food supply chain.

Addressing the key behaviours adolescents identified can have a large impact on the availability of iron-rich food at home and in the community. For example, the results of these studies can shape and reinforce the need for agricultural interventions and policies such as agricultural stipends for farm production diversification and trainings on agricultural practices that preserve iron-rich plants.

This research has implications for the design and implementation of adolescent interventions and policies. Manuscript 2 highlighted how a range of issues such as intrahousehold dynamics, gender norms, agricultural practices, lack of resources, and lack of knowledge are key influencers of rural adolescent diet. These results reinforce the need for multi-dimensional, multi-sectoral approaches to address nutrition. Manuscript 2 can also inform the priorities and shape the development of interventions and policies that address adolescent nutrition, such as the need for agricultural education programs targeted to adolescent caregivers.

There are also implications for the field of CNL promotion. Manuscript 1 provided evidence of the added value of participatory video-making in nutrition education and the use of participatory video-making as a viable educational model to promote CNL among adolescents. Results also showed that CNL improved in a demographic with poor health literacy (below grade 6 reading average) and poor functional nutrition literacy (91% of adolescents were not functionally nutrition literate at baseline). This suggests that nutrition literacy is not composed of hierarchical domains of FNL, INL, and CNL, as was previously believed. This dissertation provides evidence that CNL can be improved in a demographic with low literacy. Participatory video-making provides a viable solution for those who want to promote nutrition literacy within similar demographics.

This dissertation contributes to a particular branch of PV nutrition education research – one that looks at the influence of participatory video-making on adolescent creators' CNL, personal dietary behaviour, social action, and environmental change. It also opens avenues for new research questions and explorations. One line of inquiry is to better understand the pathway through which improved CNL influences behaviour. It would be important to also understand the factors that mediate the relationship between adolescent food choice and preferences, agency, and dietary intake.

Limitations

Manuscript 1 was limited by the tools used. A non-quantitative food frequency questionnaire is not the most sensitive dietary assessment tool and may not have recorded more subtle changes in food consumption. Furthermore, the nutrition literacy assessment tool that was used was adapted from tools that were developed for urban youth. A nutrition literacy assessment tool should be developed and validated for adolescents that live in different food environments – particularly in underserviced, rural areas. Manuscript 2 used a participatory research approach and therefore the results are limited by the perceptions and lived experiences of the intervention participants. Manuscript 2 does not claim to present the full spectrum of challenges adolescent girls faced in rural Ghana. It does, however, present the challenges adolescent girls in the study area perceived to be the most burdensome and urgent. Finally, the MSC technique used in Manuscript 3 was designed to seek out stories of change, which may influence a results bias. Results of studies that use an MSC technique are not easily generalizable because the results present the influence and value of the intervention within its unique communities and context.

Conclusion

The studies in this dissertation were designed in light of the proposed CNL framework (Figure 1.1). This dissertation provides evidence to support the initial premise that an educational program can influence CNL, and that enhanced CNL can be manifested in changes in food choice and dietary behaviour as well as an increase in engagement in social action. Additional research is needed to explore the remaining research gaps in the model – primarily, the influence of increased CNL on diet and nutrition outcomes at the individual and community level.

This dissertation provided evidence of the added value of a participatory video-making intervention in nutrition education among adolescents. A participatory video-making intervention provided a framework for adolescent girls in rural Ghana to improve CNL and its related behaviours – change in personal dietary behaviour and engagement in social action. The intervention model helped foster increased food knowledge, nurtured a desire to promote change, and provided a framework for consultation, action, and reflection. Adolescents were given the opportunity to reflect on the needs and strengths of their communities in light of new nutrition information. The girls showed 1) the desire to test the validity of the nutrition information, 2) the capacity to think critically about the nutritional issues they faced, 3) the ability to develop creative solutions, and 4) a willingness to create change. It is against this backdrop that conversations emerged among adolescents about their capacity to promote change in their lives and the life of their community. The hope is that this pilot trial may lend impetus to more efforts in involving adolescents in research that addresses their nutrition. By creating an avenue for local youth to give voice to their own stories, we widened the aperture that sheds light on adolescent nutrition. The evidence provided in this dissertation has implications on the methods used to

understand adolescent nutrition issues, and the way in which adolescent nutrition education interventions are designed, implemented, and evaluated. It unfolds a vision of what nutrition education can look like among adolescents. A participatory video-making intervention is a viable educational model to promote CNL; it can be used to help youth take their place at the forefront of community change.

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Appendix 1. Ethical clearance certificates

This Appendix presents the approval obtained by the Research Ethics Board III of McGill and the University of Ghana Ethics Committee for the Humanities with regards to the ethical acceptability of this study.

McGill

Research Ethics Board Office
James Administration Bldg.
845 Sherbrooke Street West. Rm 325
Montreal, QC H3A 0G4

Tel: (514) 398-6831
Fax: (514) 398-4644
Website: www.mcgill.ca/research/researchers/compliance/human/

Research Ethics Board III
Certificate of Ethical Acceptability of Research Involving Humans

REB File #: 212-1018

Project Title: Evaluating the effectiveness of a participatory video nutrition education trial on nutrition literacy with adolescent girls in the Upper Manya Krobo district, Ghana.

Principal Investigator: Mona Ghadirian **Department:** School of Human Nutrition

Status: Ph.D. Student **Supervisor:** Professor Grace Marquis

Co-Investigators: Neil Andersson (McGill), Naa Dodua Dodoo (University of Ghana)

Approval Period: November 21, 2018 – October 28, 2019

The REB-III reviewed and approved this project by delegated review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct For Research Involving Humans.

Lynda McNeil
Associate Director, Research Ethics

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* Approval is granted only for the research and purposes described.
* Modifications to the approved research must be reviewed and approved by the REB before they can be implemented.
* A Request for Renewal form must be submitted before the above expiry date. Research cannot be conducted without a current ethics approval. Submit 2-3 weeks ahead of the expiry date.
* When a project has been completed or terminated, a Study Closure form must be submitted.
* Unanticipated issues that may increase the risk level to participants or that may have other ethical implications must be promptly reported to the REB. Serious adverse events experienced by a participant in conjunction with the research must be reported to the REB without delay.
* The REB must be promptly notified of any new information that may affect the welfare or consent of participants.
* The REB must be notified of any suspension or cancellation imposed by a funding agency or regulatory body that is related to this study.
* The REB must be notified of any findings that may have ethical implications or may affect the decision of the REB.

Certificate of ethical acceptability of research involving humans granted by Mcgill Research Ethics Board III

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)

P. O. Box LG 571, Legon, Accra, Ghana

My Ref. No.....

5th November, 2018

Miss Mona Ziba Ghadirian,
School of Human Nutrition-McGill University
CINE Building, Macdonald Campus of McGill University
21 111 Lakeshore Road, Ste-Anne-de-Bellevue
QC, H9X 3V9, Canada

Dear Miss Ghadirian,

ECH 023/18-19: EVALUATING THE EFFECTIVENESS OF A PARTICIPATORY VIDEO NUTRITION EDUCATION TRIAL ON NUTRITION LITERACY WITH ADOLESCENT GIRLS IN THE UPPER MANYA KROBO DISTRICT, GHANA

This is to advise you that the above-referenced study has been presented to the Ethics Committee for the Humanities for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	28/10/19
On Agenda for:	Initial Submission
Date of Submission:	25/10/18
ECH Action:	Approved
Reporting:	Annually

UG/ISSER/ECH
VALID UNTIL
25 OCT 2019
APPROVED DOCUMENT

Please accept my congratulations.
Yours sincerely,

Prof. C. Charles Mate-Kole
ECH Vice Chair

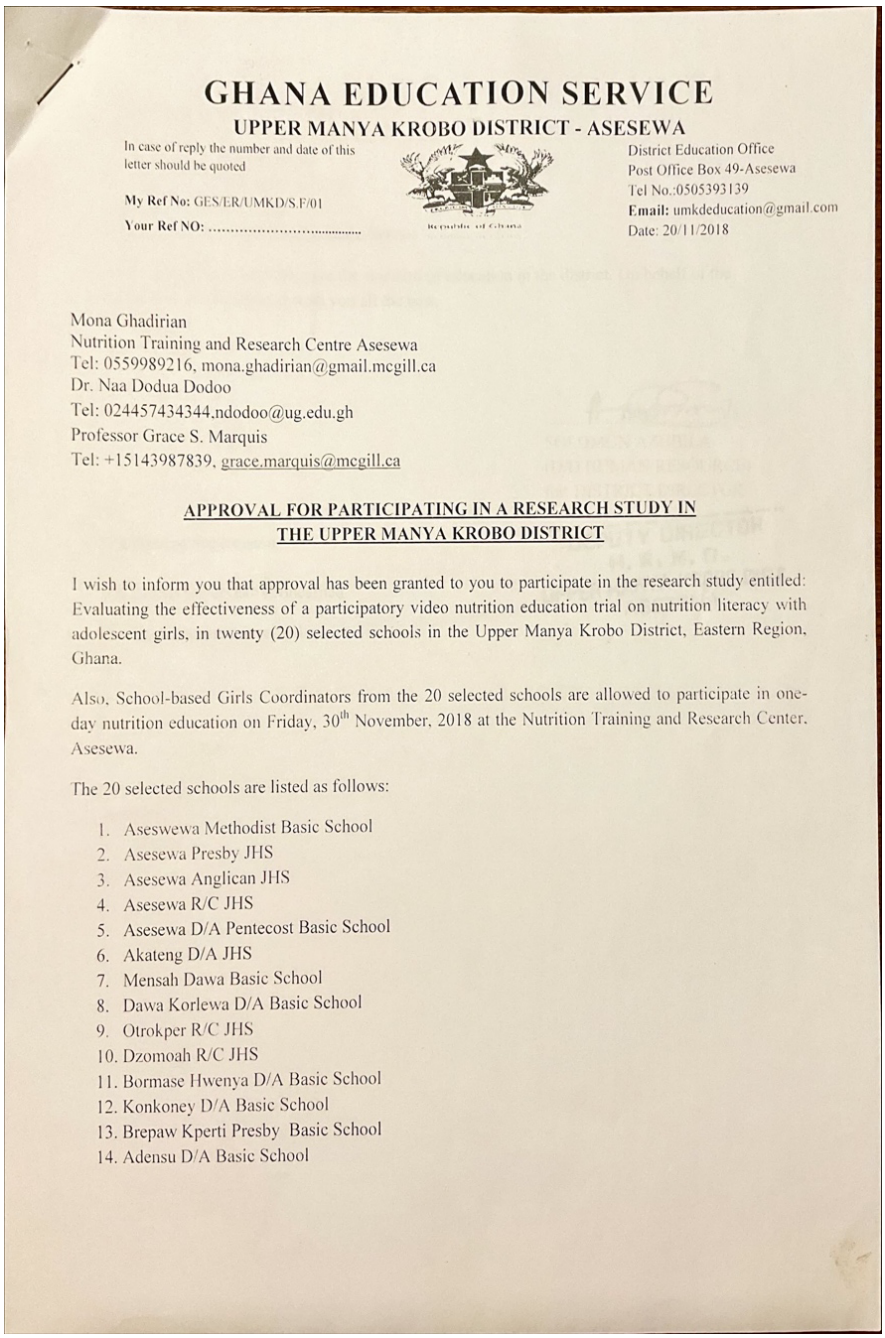
CC: Dr. Grace Marquis, Supervisor, School of Human Nutrition, McGill University, Canada
Dr. Naa Dodua Dodoo, RIPS, University of Ghana
Dr. Neil Anderson, Department of Family medicine, McGill University, Canada

Tel: + 233-303933866 Email: ech@ug.edu.gh

Certificate of project approval granted by the University of Ghana Ethics Committee for the Humanities

Appendix 2. Research study approval letter from Ghana Education Services

This Appendix presents the approval letter received from Ghana Education Services in order to proceed with this research study in the Upper Manya Krobo District in Ghana.



GHANA EDUCATION SERVICE

UPPER MANYA KROBO DISTRICT - ASESEWA

In case of reply the number and date of this letter should be quoted

My Ref No: GES/ER/UMKD/S.F/01

Your Ref NO: .....

District Education Office
Post Office Box 49-Asesewa
Tel No.:0505393139
Email: umkdeducation@gmail.com
Date: 20/11/2018

Mona Ghadirian
Nutrition Training and Research Centre Asesewa
Tel: 0559989216, mona.ghadirian@gmail.mcgill.ca
Dr. Naa Dodua Dodoo
Tel: 024457434344,ndodoo@ug.edu.gh
Professor Grace S. Marquis
Tel: +15143987839, grace.marquis@mcgill.ca

APPROVAL FOR PARTICIPATING IN A RESEARCH STUDY IN THE UPPER MANYA KROBO DISTRICT

I wish to inform you that approval has been granted to you to participate in the research study entitled: Evaluating the effectiveness of a participatory video nutrition education trial on nutrition literacy with adolescent girls, in twenty (20) selected schools in the Upper Manya Krobo District, Eastern Region, Ghana.

Also, School-based Girls Coordinators from the 20 selected schools are allowed to participate in one-day nutrition education on Friday, 30th November, 2018 at the Nutrition Training and Research Center, Asesewa.

The 20 selected schools are listed as follows:

1. Aseswewa Methodist Basic School
2. Asesewa Presby JHS
3. Asesewa Anglican JHS
4. Asesewa R/C JHS
5. Asesewa D/A Pentecost Basic School
6. Akateng D/A JHS
7. Mensah Dawa Basic School
8. Dawa Korlewa D/A Basic School
9. Otrokper R/C JHS
10. Dzomoah R/C JHS
11. Bormase Hwenya D/A Basic School
12. Konkoney D/A Basic School
13. Brepaw Kperti Presby Basic School
14. Adensu D/A Basic School

15. Akohia Anglican Basic School
16. Sisiamang Yiti D/A Basic School
17. Fefe Presby Basic Schools
18. Sawa Yiti Presby Basic School
19. Bisa D/A Central JHS
20. Asesewa Nashrudin Islamic Basic School

I hope the project would improve the standard of education in the district. On behalf of the directorates of education, I wish you all the best.

SOLOMON AZUBILA
(D/D HUMAN RESOURCE)
for: DISTRICT DIRECTOR

DEPUTY DIRECTOR
H. R. M. D.
UPPER MANYA KROBO DIST.
ASESEWA

cc:
The Head of Supervision

The Circuit Supervisors concerned

The Headteachers concerned

Appendix 3. Satellite view of clusters in cluster randomized controlled trial

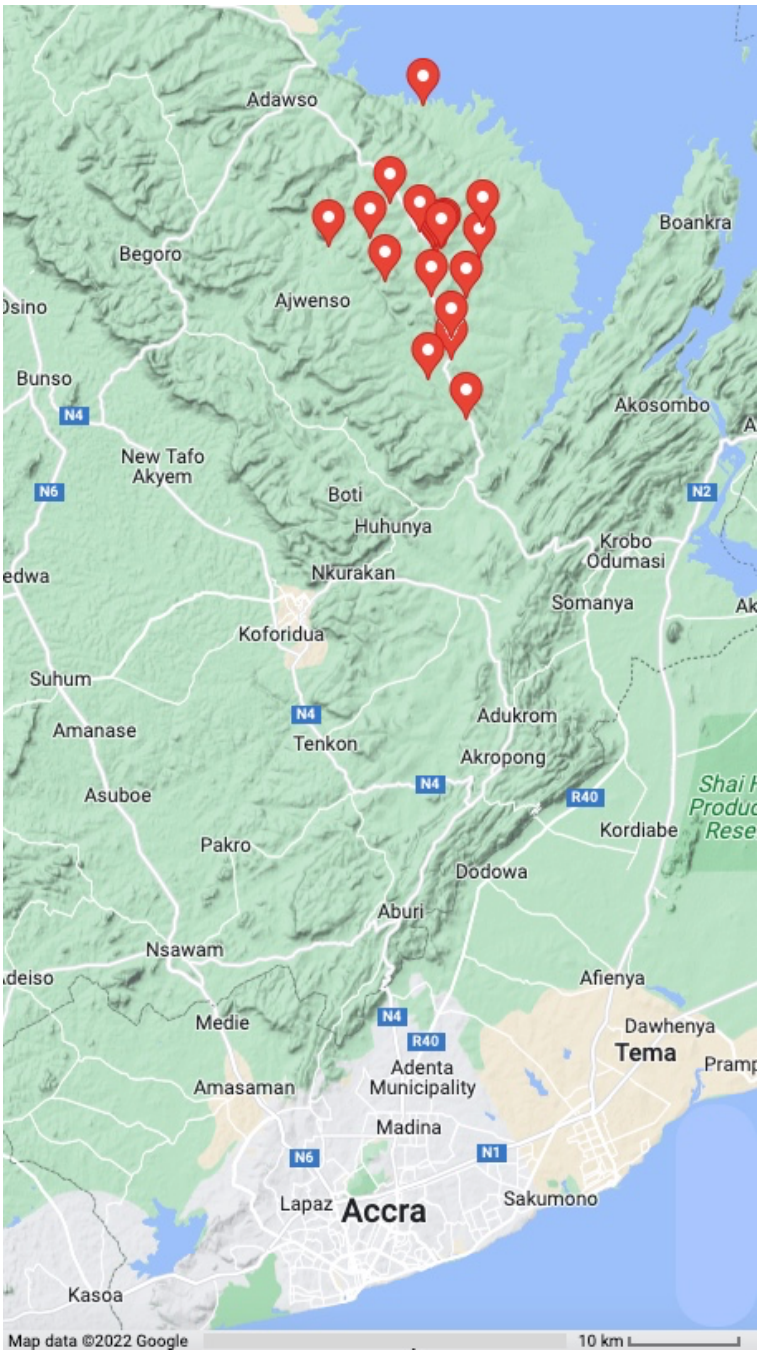


Figure A3.1 – Map of the participating schools in the cluster randomized controlled trial

Figure A3.2 – Close up map of the participating schools in the cluster randomized controlled trial within the Upper Manya Krobo district

Appendix 4. Guardian / parental consent and participant assent forms

UNIVERSITY OF GHANA

Ethics Committee for Humanities (ECH)

Official Use only
Protocol number

GUARDIAN/ PARENTAL PROTOCOL CONSENT FORM

Section A- BACKGROUND INFORMATION

Title of Study	Evaluating the effectiveness of a participatory video nutrition education trial on nutrition literacy with adolescent girls in the Upper Manya Krobo district, Ghana.
Principal Investigator	Mona Ghadirian, PhD Candidate, McGill University
ClinicalTrials.gov ID	NCT03704649

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

Purpose of the Study: The goal of this research project is to study how different ways of teaching nutrition can influence adolescent girls' nutrition knowledge and diet in Upper Manya Krobo (UMK) district, Ghana. During the 2018-2019 school year, 20 schools in the district will be chosen at random to receive either (i) the usual nutrition education given in the girls' club meetings or (ii) a program where girls' clubs will make short films about nutrition topics, such as how to prevent anemia and choose a balanced diet.

The information from this research study may help improve nutrition education for adolescents.

Study Procedures*:* If you consent to your daughter participating in this research study, she will answer a questionnaire that will take about 30-45 minutes. She will be asked about herself and her family (for example, age, schooling, occupation), what she knows about food and nutrition, her diet, and how she spends her free time. Her weight and height will be taken. She will be asked similar questions at the end of the school year.

All girls will continue to participate in their regular weekly girls' club meetings held at the school and led by school teachers. If her school is chosen for the participatory video intervention, your daughter will be invited to participate in film making activities afterschool like writing a play about healthy eating habits and acting in the play. They will be taught how to use a video camera and make a short 5-7 minute film based on the story they wrote. She may have the opportunity to be in the films the group will produce that will be shown to her fellow club members. She will only be video-taped with your consent and her assent. Not being video-taped does not affect her participation in the intervention.

Whether your daughter is in the intervention group or not, she may be asked to participate in an additional interview. The purpose of this interview is to better understand her experience in the girls'

club, what nutrition information she remembers from the lessons, what helped her and what challenges she faced in putting into practice what she learned. The interview will be about 30 minutes.

Benefits/Risks of the study

This research aims to increase the understanding of nutrition information and improve the diet of adolescent girls. There are no known risks to your daughter's physical, mental or emotional health by being part of the study.

Confidentiality

All information will be confidential, which means that we will not tell anyone what your daughter says or give out any information about your family and your daughter. Only the researchers and field workers will have access to this information.

Each participant will be given a code number to protect the participant's identity. With your consent and her assent, interviews will be audio-recorded and then translated and written out for our records. Audio files of interviews will be deleted after the study is finished and they are only for the use of the researcher. All equipment used in collecting or storing data will be password protected. Hard copies of consent forms, transcripts, and demographic data will be stored in a locked storage cabinet at University of Ghana and McGill University.

In addition to the researchers, community health workers and school teachers tied to the girls' clubs will have a copy of the final films made by the girls to use in their educational activities. Your daughter will not be named in any oral or written reports however, when the films are shared with the community, those girls who are filmed will be seen. You and your daughter have the right to decline from being video-taped for the video intervention, and your decline will not affect your participation in the research study in any way.

Compensation There is no payment for participating in this research study.

Voluntary Participation / Withdrawal from Study

Participation in the research activities is voluntary and your daughter can choose to not answer any question or to leave the study at any time. You and your daughter will not be affected negatively in any way if your daughter does not participate.

Contact for Additional Information

If you have questions about the research study, please contact the Principal Investigator, Mona Ghadirian, or any of the co-investigators listed below.

Principal Investigator	**Mona Ghadirian, PhD Candidate** School of Human Nutrition, McGill University CINE Building, Macdonald Campus of McGill University 21 111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, H9X 3V9, Canada Tel: 055 998 9216 or +1 514-835-6884, Email: Mona.Ghadirian@mail.mcgill.ca

Supervisor	**Dr. Grace Marquis, Associate Professor** School of Human Nutrition, McGill University CINE Building, Macdonald Campus of McGill University 21 111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, H9X 3V9, Canada Tel: +1 514-398-7839, Email: Grace.Marquis@mcgill.ca
Collaborators	**Dr. Naa Dodua Dodoo, Lecturer** Regional Institute for Population Studies, University of Ghana, Legon, Ghana Tel: +233 24 457 4434, Email: NDodoo@ug.edu.gh. **Dr. Neil Andersson, Professor** Department of Family Medicine, McGill University 5858 chemin de la Cote-des-Neiges, Montreal, Quebec, H3S 1Z1, Canada Tel: +1 514-398-7375, Email: Neil.Andersson@mcgill.ca

If you have any questions about your rights as a research participant in this study you may contact the Administrator of the Ethics Committee for Humanities, ISSER, University of Ghana at ech@isser.edu.gh / ech@ug.edu.gh or 00233- 303-933-866.

If you have any ethical concerns or complaints about your participation in this study, and want to speak with someone not on the research team, please contact the McGill Ethics Manager at + 1 514-398-6831 or lynda.mcneil@mcgill.ca.

Section C- PARTICIPANT AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and am willing to give consent for me, my child/ward to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

Please read and indicate your responses:

Yes:____No:____You consent to your daughter participating in the survey questionnaires.

Yes:____No:____You consent to your daughter participating in an interview.

Yes:____No:____You consent to your daughter being audio recorded for the interview.

Yes:____No:____For intervention groups only, you consent to your daughter participating in the film activities.

Yes:____No:____You consent to your daughter being filmed and photographed.

Name of Participant: (please print) _____

Signature or Thumb-print of Participant:_____Date:_____

If participant cannot read and/or understand the form themselves:
Space is given above if the participant's thumb-print is needed instead of a signature and a witness must sign here.

"I was present while the benefits, risks and procedures were read to the participant. All questions were answered and the volunteer has agreed to take part in the research."

Name of Witness: (please print) _____

Signature of Witness:_____Date:_____

"I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this research have been explained to the above individual."

Name of person who obtained consent: (please print) _____

Signature of person who obtained consent:_____Date:_____

UNIVERSITY OF GHANA

Ethics Committee for Humanities (ECH)

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PROTOCOL ASSENT FORM FOR ADOLESCENT

Section A- BACKGROUND INFORMATION

Title of Study	Evaluating the effectiveness of a participatory video nutrition education trial on nutrition literacy with adolescent girls in the Upper Manya Krobo district, Ghana.
Principal Investigator	Mona Ghadirian, PhD Candidate, McGill University
ClinicalTrials.gov ID	NCT03704649

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Purpose of the Study: The goal of this research project is to study how different ways of teaching nutrition can influence adolescent girls' nutrition knowledge and diet in Upper Manya Krobo (UMK) district, Ghana. During the 2018-2019 school year, 20 schools in the district will be chosen at random to receive either (i) the usual nutrition education given in the girls' club meetings or (ii) a program where girls' clubs will make short films about nutrition topics, like how to prevent anemia and choose a balanced diet.

The information from this research study may help improve nutrition education for adolescents.

Study Procedures*:* If you agree to participating in this research study, you will answer a questionnaire that will take about 30-45 minutes. You will be asked about yourself and your family (for example, age, schooling, occupation), what you know about food and nutrition, your diet, and how you spend your free time. Your weight and height will be taken. You will be asked similar questions at the end of the school year.

All girls will continue to participate in their regular weekly girls' club meetings held at the school and led by school teachers. If your school is chosen for the participatory video intervention, you will be invited to participate in film making activities afterschool like writing a play about healthy eating habits and acting in the play. You will be taught how to use a video camera and make a short 5-7 minute film based on the story you wrote. You may have the opportunity to be in the films the group will produce that will be shown to your fellow club members. You will only be video-taped if you and your guardian say you're okay with it. Not being video-taped does not affect your participation in the intervention.

Whether you are in the intervention group or not, you may be asked to participate in an additional interview. The purpose of this interview is to better understand your experience in the girls' club, what nutrition information you remember from the lessons, what helped and what challenged you in putting into practice what you learned. The interview will be about 30 minutes.

Benefits / Risks of the study

This research aims to increase the understanding of nutrition information and improve the diet of adolescent girls. There are no known risks to your physical, mental or emotional health by being part of the study.

Confidentiality

All information will be confidential, which means that we will not tell anyone what you say or give out any information about your family and yourself. Only the researchers and field workers will have access to this information.

Each participant will be given a code number to protect the participant's identity. With your parent's consent and your assent, interviews will be audio-recorded and then translated and written out for our records. Audio files of interviews will be deleted after the study is finished and they are only for the use of the researcher. All equipment used in collecting or storing data will be password protected. Hard copies of consent forms, transcripts, and demographic data will be stored in a locked storage cabinet at University of Ghana and McGill University.

In addition to the researchers, community health workers and school teachers tied to the girls' clubs will have a copy of the final films made by the girls to use in their educational activities. You will not be named in any oral or written reports however, when the films are shared with the community, those girls who are filmed will be seen. You and your guardian have the right to decline from being video-taped for the video intervention, and your decline will not affect your participation in the research study in any way.

Compensation There is no payment for participating in this research study.

Voluntary Participation / Withdrawal from Study

Participation in the research activities is voluntary and you can choose to not answer any question or to leave the study at any time. You and your guardian will not be affected negatively in any way if you choose not to participate.

Contact for Additional Information

If you or your guardian have questions about the research study, please contact the Principal Investigator, Mona Ghadirian, or any of the co-investigators listed below.

Principal Investigator	**Mona Ghadirian, PhD Candidate** School of Human Nutrition, McGill University CINE Building, Macdonald Campus of McGill University 21 111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, H9X 3V9, Canada Tel: 055 998 9216 or +1 514-835-6884, Email: Mona.Ghadirian@mail.mcgill.ca
Supervisor	**Dr. Grace Marquis, Associate Professor** School of Human Nutrition, McGill University CINE Building, Macdonald Campus of McGill University

	21 111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, H9X 3V9, Canada Tel: +1 514-398-7839, Email: Grace.Marquis@mcgill.ca
Collaborators	**Dr. Naa Dodua Dodoo, Lecturer** Regional Institute for Population Studies, University of Ghana, Legon, Ghana Tel: +233 24 457 4434, Email: NDodoo@ug.edu.gh. **Dr. Neil Andersson, Professor** Department of Family Medicine, McGill University 5858 chemin de la Cote-des-Neiges, Montreal, Quebec, H3S 1Z1, Canada Tel: +1 514-398-7375, Email: Neil.Andersson@mcgill.ca

If you have any questions about your rights as a research participant in this study you may contact the Administrator of the Ethics Committee for Humanities, ISSER, University of Ghana at ech@isser.edu.gh / ech@ug.edu.gh or 00233- 303-933-866.

If you have any ethical concerns or complaints about your participation in this study, and want to speak with someone not on the research team, please contact the McGill Ethics Manager at + 1 514-398-6831 or lynda.mcneil@mcgill.ca.

Section C- PARTICIPANT AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and am willing to give consent for me, my child/ward to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

Please read and indicate your responses:

Yes:____No:____You consent to participating in the survey questionnaires.

Yes:____No:____You consent to participating in an interview.

Yes:____No:____You consent to being audio recorded for the interview.

Yes:____No:____For intervention groups only, you consent to participating in the film activities.

Yes:____No:____You consent to being filmed and photographed.

Name of Participant: (please print) _____

Signature or Thumb-print of Participant:_____Date:_____

If participant cannot read and/or understand the form themselves:
Space is given above if the participant's thumb-print is needed instead of a signature and a witness must sign here.

"I was present while the benefits, risks and procedures were read to the participant. All questions were answered and the volunteer has agreed to take part in the research."

Name of Witness: (please print) _____

Signature of Witness:_____Date:_____

"I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this research have been explained to the above individual."

Name of person who obtained consent: (please print) _____

Signature of person who obtained consent:_____Date:_____

Appendix 5. Community Advisory Board terms of reference

Evaluating the Effectiveness of a Participatory Video
Nutrition Education Trial on Nutrition Literacy
With Adolescent Girls in the Upper Manya Krobo District, Ghana.

Community Advisory Committee
Terms of Reference & Project Overview

1. BACKGROUND

Adolescent girls in the Upper Manya Krobo (UMK) district, Ghana are disproportionately burdened by ill-health in relation to their male counterparts. Research also shows that this demographic lacks access to nutrition education and health services. This research aims to assess the feasibility and influence of an intervention that utilizes a participatory video education model on adolescent girls' nutrition knowledge, dietary habits and health behaviour. To address our research objectives, we will conduct a school-based cluster randomized control pilot trial with adolescent girls, 12-16 years of age, who are part of existing girls' clubs in 20 schools of the Upper Manya Krobo district. The intervention group (10 schools) will use a participatory video education model and the control group consists of standard-of-care education received in regular girls' club gatherings. The intervention groups develop a storyboard and produce a short 5-7 minute film on a nutritional issue. These videos can be used by teachers as a means of sharing nutrition information with students and in stimulating discussion around the nutrition topic. Baseline and end line surveys will be conducted to assess nutrition literacy indicators and nutrition behaviour. We will use surveys to assess nutritional knowledge and attitude; food frequency questionnaire to record dietary intakes; and in-depth interviews with participants and school staff to assess challenges and strengths of the nutrition education model being delivered

2. ROLE OF THE COMMUNITY ADVISORY BOARD

The role of the Community Advisory Board is as follows:

- Provide insights to the team regarding
  - Stakeholder interests
  - Technical advice
  - Other relevant initiatives
- Assist with resolving issues and risks.
- Use influence and authority to assist the project in achieving its outcomes.
- Communicate about the project in their organizations.

3. RESPONSIBILITIES OF THE PRINCIPAL INVESTIGATOR

The Principal Investigator is Mona Ghadirian.
The responsibilities of the Principal Investigator are as follows:

- Responsible for the coordination and implementation of all research and intervention related activities.
- Sets the agenda for each meeting and ensures that agendas and supporting materials are prepared.
- Makes the purpose of each meeting clear to members and explains the agenda at the beginning of each meeting.
- Provides summaries of the study's progress and presents issues that have arisen in the field.
- Ends each meeting with a summary of advice provided and assignments.

4. RESPONSIBILITIES OF COMMUNITY ADVISORY BOARD MEMBERS

Individual Advisory Board members have the following responsibilities:

- Understand the goals, objectives, and desired outcomes of the project.
- Take a genuine interest in the project's outcomes and overall success.
- Act on opportunities to communicate positively about the project.
- Actively participate in meetings through attendance, discussion, and review of papers and other Advisory Board documents.
- Support open discussion and debate, and encourage fellow Advisory Committee members to voice their insights.

5. GENERAL

5.1 Membership

The table below lists the membership of the Community Advisory Committee.

Name	Title	Organization

5.2 Frequency of Meetings

The Community Advisory Board will meet on a monthly/bimonthly basis or whenever necessary to follow the progress of the project, to address arising issues and to consult on next steps.

6. DETAILED STUDY DESCRIPTION

6.1 Overview

Although there are a number of health and nutrition services targeted to adolescent girls in rural Ghana, there continues to be a high prevalence of anemia, preventable ailments, and teen pregnancies among adolescent girls in the Upper Manya Krobo district (DHS, 2014). This project builds on a health literacy framework and social cognitive theory and explores salient features in nutrition education delivery with adolescent girls in the Upper Manya Krobo district of Ghana, and investigates their influence on nutritional knowledge and behaviour.

The primary research objective is
(1) to assess the feasibility of a participatory nutrition education model in the Upper Manya Krobo district and,
(2) to determine if there is a difference in adolescent girls' nutrition literacy between the intervention and control groups.

The research will provide a process evaluation and offer insight into a replicable and feasible protocol that can implemented in other schools. We hypothesize that there will be a difference in nutrition literacy indicators and dietary patterns between intervention and control groups.

To address our research objectives, we will conduct a school-based cluster randomized control pilot trial with adolescent girls, 12-16 years of age, who are part of existing girls' clubs in 20 schools of the Upper Manya Krobo district. Eligible clusters consist of primary and/or junior high schools in UMK district that are implementing standardized girls' clubs and who intend to continue to implement girls' clubs for the upcoming 2018-2019 school year (n = 59). Clusters will be stratified based on 1) the presence of the school feeding program and 2) accessibility to the school. Accessibility will be based on the quality of roads and time needed to travel to the cluster from the district capital, Asesewa. After stratification, clusters will be randomized into control and treatment arms. In each cluster, approximately 20 female adolescent girls' club participants who are 12-16 years of age will be randomly selected and enrolled in the study through seeking informed guardian's consent and adolescent's assent.

The control groups (10 schools) represent the standard-of-care. Participants in these clubs meet on a weekly basis during designated time for club activities in the school schedule. With the guidance of their club facilitator they talk about a variety of health and nutrition topics. The intervention groups (10 schools) will follow a similar curriculum and will include a participatory video education model. The intervention groups develop a storyboard and produce a short 5-7 minute film on a nutritional issue where they are the individuals who draft the script, create the characters, video-record the

shots, and act (if they wish) in the video. These videos will be used in the group as a means of sharing nutrition information with students and in stimulating discussion around the nutrition topic.

6.2 Data Collection Procedures

Phase 1: Baseline survey and weight/height
Baseline surveys will be conducted to assess nutrition literacy indicators and nutrition behaviour. Survey questionnaires will be administered at baseline by trained research assistants using electronic tablets. The Open Data Kit (ODK) software will be downloaded onto Samsung Tab3 tablets that will be used to record survey questionnaire responses. This survey will take about 30-45 minutes and will be conducted in a private location on the student's school campus. We will use surveys to assess nutritional knowledge and attitude; questionnaires to record dietary intakes. She will be asked about herself and her family (for example, age, schooling, occupation), what she knows about food and nutrition, her diet, and how she spends her free time. Her weight and height will be taken.

Phase 2: Intervention
The proposed intervention entails the active engagement of key community members, community-based organizations and governmental institutions in the UMK district. A community advisory board (CAB) is formed by key stakeholders, including health professionals, community health workers, government officials, and influential community members. Their primary role is to follow the development of the project, help to identify key health and nutrition messages, to ensure the credibility of the health message being disseminated, and to help strengthen community connections necessary for the seamless execution of the research-related activities.

A minimum of two girl club facilitators per school will attend a training to review health and nutrition themes dictated in the girls' club standard curriculum. Facilitators from intervention schools will participate in additional film production workshops where they are trained on how to write storyboards and scripts, and use microphones and cameras to make short 5-7 minute films. In the intervention girls' clubs sessions, the facilitators lead a discussion on nutrition topics and assist the girls to develop a scenario, storyboard and script for the educational video they will produce. A script is written in the local Krobo dialect and auditions are held in their club to cast the various roles. After the video is produced, it is viewed and approved by members of the CAB, to ensure that material is culturally appropriate and that the nutrition information is accurate. The video is made available to girls' club teachers who will screen it for the students with the use of a battery operated pico projector and speakers, after which the audience is prompted to reflect on the video being watched. Each intervention group will produce two videos on the nutrition topics covered in the girls' club session.

Throughout this time, observations will be gathered regarding attendance, and the content of the nutrition messages delivered in the girls' club sessions.

Phase 3 – In-depth interview and Focus group discussion
In-depth interviews will be conducted with participants. Whether the female participant is in the intervention group or not, she may be selected to be interviewed based on the recommendation of her club facilitator through purposive typical case sampling. This is done so as to gain insight on the influence of the educational curriculum and/or intervention on the average student. The purpose of this interview is to better understand her experience in the girls' club, what nutrition information she remembers from the lessons, what helped her and what challenges she faced in putting into practice what she learned. The most significant change methodology is used in the interview guide design. The interview will be about 30 minutes.

These interviews will be conducted in a private location at their schools after the guardian's informed consent and participant informed assent is given.

Focus group discussions will also be conducted with staff and community members that were associated to the girls' club activities. The purpose of this focus group discussion is to better understand their experience with the girls' club sessions. Focus group discussions will provide insights into helpful aspects or challenges that were faced when supporting the girls' club activities. Other questions will focus on the changes they may have noticed in the participant's understanding and attitude towards nutrition and changes in their eating behaviour. The focus group discussion will be about 30-45 minutes.

Phase 4 – Post-intervention surveys and weight/height
Surveys will be conducted with the girl participants at the end of the school year when the intervention is completed. Surveys will be used to assess changes in nutrition literacy indicators and nutrition behaviour.

Data management and analysis
Data from these surveys will be downloaded into a password protected and secured laptop at the end of every day and then deleted off the tablet. Data will be backed up on an external hard drive that is located in a locked cabinet of the offices in the Nutrition Research and Training Centre in Asesewa.

Each participant will be given a code number to protect the participant's identity. With their guardian's consent and the participant's assent interviews will be audio-recorded and then translated and written out for our records. Audio files of interviews will be deleted off equipment after the study is finished and they are only for the use of the researcher. All equipment used in collecting or storing data will be password protected. Hard copies of consent forms, transcripts, and demographic data will be stored in a locked storage cabinet at University of Ghana and McGill University.

In addition to the researchers, community health workers and school teachers tied to the girls' clubs will have a copy of the final films made by the girls to use in their educational activities.

6.3 Arms and intervention

Arm	Intervention/treatment
Control: Standard nutrition education approach	**Behavioural: Passive nutrition education approach** The control clusters (10 schools) represent the standard-of-care. Participants in these girls' clubs meet on a weekly basis during designated time for club activities in the school schedule. With the guidance of their club facilitator they talk about a variety of health and nutrition topics.
Experimental: Participatory nutrition education approach	**Behavioural: Participatory nutrition education approach** Participants from intervention clusters meet for their girls' clubs on a weekly basis during designated time for club activities in the school schedule. With the guidance of their club facilitator they talk about a variety of health and nutrition topics. In addition, the intervention groups produce a short 5-7 minute film on the nutritional topic covered in the girls' club sessions. Participants are taught how to use film equipment and accompanied to draft scripts, create characters, video-record the shots, and act (if they wish) in the video. These videos will be used in the group as a means of sharing nutrition information with students and in stimulating discussion around the nutrition topic.

6.4 Outcome Measures
- **Primary outcomes**
    - Change in nutrition literacy indicators assessed by survey questionnaire.
- **Secondary outcomes**
    - Change in psychological health behaviour change indicators such as self-efficacy and intention, assessed by survey questionnaire
    - Change in dietary choices assessed by a food frequency questionnaire within the survey questionnaire
    - Input into the feasibility of the protocol emerging from focus group discussions and in-depth interviews

6.5 Eligibility Criteria - Participants
- Inclusion Criteria
    - Is a female participant of girls' club in the school that was randomly selected to participate in the study
    - Resides in the Upper Manya Krobo district.
    - Is 12 to 16 years of age
- Exclusion Criteria
    - Does not speak local dialect – Krobo.

6.6 Contacts
- Investigators

- **Mona Ziba Ghadirian, PhD Candidate - BASc, MPH**
  School of Human Nutrition - McGill University CINE Building, Macdonald Campus of McGill University, 21 111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, H9X 3V9, Canada.
  Tel: +1 514-398-7839, 055 998 9216, Email: Mona.Ghadirian@mail.mcgill.ca

- **Dr. Grace Marquis, Supervisor & Associate Professor – BA, MSc, PhD**
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  CINE Building, Macdonald Campus of McGill University,
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  Regional Institute for Population Studies, University of Ghana, Accra, Ghana
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- **Dr. Neil Andersson, Professor – MD, PhD**
  Department of Family Medicine, McGill University
  5858 chemin de la Cote-des-Neiges – Third floor, Montreal, Quebec, Canada
  Tel: 514-398-7375, Email: Neil.Andersson@mcgill.ca

6.7 More Information

- Funding from the Canadian Queen Elizabeth II Diamond Jubilee Scholarship
- ClinicalTrials.gov identifier: NCT03704649
- Human Subjects Protection Review Boards:
  - University of Ghana – Institute Statistical, Social and Economic Research
    - Contact information for the Administer of the Ethics Committee for Humanities
      Tel: 00233- 303-933-866 or ech@isser.edu.gh / ech@ug.edu.gh

  - McGill University – Research Ethics Board III
    - Contact information for the McGill Ethics Manager
      Tel: + 1 514-398-6831 or lynda.mcneil@mcgill.ca.

Appendix 6. Timeline of data collection

Appendix 7. Participant baseline questionnaire in a cluster randomized controlled trial

This Appendix presents the interview guide and questions used in this research study.

Survey questions for adolescent girls - v4

The following survey will be administered with the use of tablets. The use of the ODK software on tablets allows for research assistants to ask the survey questions below and to record the participant's answers on the tablet such that it can later be uploaded to a secure computer.

Demographic information

Thank you for taking the time to meet with me. I would like to start by asking a few basic questions about yourself.

Age

- How old are you?
- In what year were you born?

Education (ACS, wave 1)

- Now let's talk about your schooling experiences. What level are you currently in?
    - K1-K2 / Primary/ Middle-JSS / Don't know/ no response
- What grade are you currently in?

Puberty

- Now moving onto another topic. Let's talk about growing up and new experiences.
  As girls grow into women, certain changes happen to their bodies which are very normal.
  One of these changes is that they start to have menstruation periods.
  Have you had your first menstruation period yet?
    - Yes / No/ Don't know/ No response
- How old were you when this happened?

Socioeconomic status (Alicke, 2017)

- Basic assessment of literacy. – Schonell Reading Test

Notes for you (don't read aloud): Instructions For Administering The Test. The Test should be given in a friendly atmosphere in which the child is thoroughly at ease. Start the test at the beginning. Testing is discontinued when ten consecutive words are failed. Do not help the child. Don't ask to repeat a word that he has almost but not quite pronounced correctly nor should he be given any clues as to how to attack a particular word. Credit should not be given unless the word is clearly correct e.g. 'flowers' for 'flower' is incorrect as is 'postage' when the last syllable is pronounced as the word 'age'.

- What level of schooling did your mother reach?
    - None/ Primary/ Middle/JHS/ Secondary/ Tertiary / Other: __ / I don't know / No response
- What is your mother's main job? Is she a:

    - Subsistence farmer / Commercial farmer / Casual laborer/ Artisan / Trader/ Businesswoman/ Public servant / Unemployed / Other: __ / I don't know / No response
    - If other, please specify: _____

- And what about your father, what level of schooling did your father reach?
    - None/ Primary/ Middle/JHS/ Secondary/ Tertiary / Other: __ / I don't know / No response
    - If other, please specify: _____
- What is your father's main job? Is he a:
    - Subsistence farmer / Commercial farmer / Casual laborer/ Artisan / Trader/ Businesswoman/ Public servant / Unemployed / Other: __ / I don't know / No response
    - If other, please specify: _____

- Now I'll read out a list of objects and you tell me (yes or no) what you have in your home
    - Household's physical assets:
        - Electricity
        - Pipe-borne water
        - Radio
        - Fan
        - Kitchen Cupboard
        - Television
        - Bicycle
        - Motor-bike
        - Refrigerator
        - Car/truck
        - Tractor
        - Cattle
        - Goat/chickens

Food intake (ACS, wave 1)

I would like to ask you a few questions regarding your daily food intake.

The next set of questions ask about specific type of foods you may have eaten over the last week.

- Over the last week, have you eaten: carrots, orange-fleshed sweet potatoes, colored yams or any other vegetables that are yellow or orange?
    - Yes/ No
- Over the last week, have you eaten foods made with red palm oil, red palm nut, or red palm nut pulp sauce?
    - Yes/ No
- … any dark green leafy vegetables such as kontommire, aleefu, bokoboko, ayoyo?
    - Yes/ No
- …any turkey berry?
    - Yes/ No
- … any okra, garden egg, or plantain?
    - Yes/ No

- … liver, kidney, heart, gizzard, or any other organ?
    - Yes/ No
- … any meat such as beef, pork, lamb, goat?
    - Yes/ No
- … any other meat, such as chicken or guinea fowl?
    - Yes/ No
- … smoked/fried/dried/cooked fish, shellfish, or other seafood (excluding powdered fish)?
    - Yes/ No
- … any food made from beans?
    - Yes/ No
- … any food made from peas, lentils, nuts, or seeds including agushi, soybean, groundnut, or groundnut paste?
    - Yes/ No
- … cheese, yogurt, or other milk products including milk drinks, local cheese such as wagashi?
    - Yes/ No
- … any grains, whole wheat, bread, brown rice, or cereals?
    - Yes/ No
- … any tomatoes?
    - Yes/ No
- … any orange, pawpaw, mango, pineapple?
    - Yes/ No
- … other fruits such as avocado, pear, apple, watermelon, banana?
    - Yes/ No
- … eggs?
    - Yes/ No
- … tea or coffee?
    - Yes/ No
- … dark chocolate
    - Yes/No
- … iron supplements?
    - Yes/ No

Access to nutrition information

- When you buy packaged food, what nutrition information do you notice on the package wrapping? (don't read out the list)
    - Brand name
    - Picture
    - Ingredients
    - Nutritional Facts
    - Other
    - If other, please specify
    - I don't know

- In the past 12 months, did you receive any nutritional information? By nutritional information, we mean what is healthy to eat, how often to eat, and what types of foods to avoid. *(If no, skip the following two questions).*
    - Yes/ No/ Don't know/ No response
- Where did you receive this information? *Select multiple answers (don't read out options)*
    - In school/ Local clinic/ Local community activities or events/ Home/ Peers/ Radio/ TV/ Information Centre/ Church/ Other/ Don't know/ No response
    - If other, please specify
- What language was the nutrition information you received?
    - English/ Krobo/ Other/ Don't know/ No response
    - If other, please specify

- Have you *ever* **purposefully looked for** information about nutrition, diet or food from any source?
  □ Yes □ No *(if No, skip next two questions)*
- The most recent time you searched for information about nutrition, diet or food, where did you go first? (Mark only one).
  □ Books □ Brochures, pamphlets, etc. □ Family □ Friend/classmate □ Doctor or healthcare provider □ Internet □ Library □ Magazines □ Newspapers □ Complementary, alternative, or unconventional practitioner □ Television □ Radio □ Other (specify)…….
- Did you look or search or go anywhere else? (Mark all that apply)
  □ Books □ Brochures, pamphlets, etc. □ Family □ Friend/classmate □ Doctor or healthcare provider □ Internet □ Library □ Magazines □ Newspapers □ Complementary, alternative, or unconventional practitioner □ Television □ Radio □ Other (specify)……
- How confident are you that you could get nutrition-related advice or information if you needed it? *(Mark only one).*

How confident are you?	Completely confident □	Very confident □	Somewhat confident □	A little confident □	Not confident at all □

- In the past 12 months, did you learn about the following health and nutrition information **in your classroom.** By this, we mean things that your teacher might have taught you in science, biology and other classes. Did you learn about _____ in class?
  (Interviewer: Read out each option: 0 – No, 1 – Yes, 98 – Don't know, 99 – No response)
    - Ways to prepare and store food safely
    - What foods may be healthy to eat
    - What to eat during menstration
- In the past 12 months, did you learn about the following health and nutrition information **at home and/or from your family or relatives**? Did you learn about _____ at home?
  (Interviewer: Read out each option. 0 - No, 1 – Yes, 98 – Don't know, 99 – No response)
    - Ways to prepare and store food safely
    - What foods may be healthy to eat
    - What to eat during menstration

- In the past 12 months, did you learn about the following health and nutrition information **in the girls' club?** Did you learn about _____ at home?
  (Interviewer: Read out each option. 0 - No, 1 – Yes, 98 – Don't know, 99 – No response)
  - Ways to prepare and store food safely
  - What foods may be healthy to eat
  - What to eat during menstration

- In the past 12 months have you had your blood tested for iron?
  - Yes/ No/ I don't know/ No response
- In the past 12 months have you been told you have anemia?
  - Yes/ No/ I don't know/ No response
- If yes, who told you that you had anemia?
  - Health professional/ family members/ other/ I don't know/ No response
  - If other, please specify: _____
- If yes, what did they recommend that you do? *(don't read the options)*
  - Change in diet
  - Iron supplementation
  - Blood transfusion
  - Stay out of the sun
  - Other
  - I don't know
  - No response
  - If other, please specify: _____

How do girls spend their time? (ACS, wave 4)

- During the last week, how many days did you play sports or exercise for at least 1 hour? By exercise I mean, any activity that needs your muscles to work hard - this can include working in the farm or walking long distances.
- In the last week, who decided what meals were prepared at home? You alone, together with someone, or someone else?
  - 1 – You alone
  - 2 – Together with someone
  - 3 – Someone else
  - 98 – Don't know
  - 99 – No response
- Who is this other person?
  - 1 – Mother
  - 2 – Father
  - 3 – Grandmother
  - 4 – Grandfather
  - 5 – A sibling
  - 6 – Another adult relative
  - 7 – Boyfriend/Husband
  - 98 – Don't know
  - 99 – No response

- In the last week, who prepared most of the meals at home? You alone, together with someone, or someone else?
    - 1 – You alone
    - 2 – Together with someone
    - 3 – Someone else
    - 98 – Don't know
    - 99 – No response
- Who is this other person?
    - 1 – Mother
    - 2 – Father
    - 3 – Grandmother
    - 4 – Grandfather
    - 5 – A sibling
    - 6 – Another adult relative
    - 7 – Boyfriend/Husband
    - 98 – Don't know
    - 99 – No response
- In the last week how many times did you go to the market/shop/kiosk to purchase anything to eat, a snack or a meal, for yourself?
    - _____
    - 98 – Don't know
    - 99 – No response

A Rapid Estimate of Adolescent Literacy in Medicine (REALM – TeenS)(Manganello, 2017)

Note to administrator: "Give the patient the laminated copy of the REALM-Teen word list. Hold the [tablet] at an angle such that the patient is not distracted by your scoring procedure. In your own words, introduce the REALM-Teen to the patient:"

- We are trying to get an idea of what health words people your age are familiar with. What I need you to do is say each of the words out loud to me starting here *(point to first word with pencil)*
- Say all the words you know. If you come to a word you don't know, you can sound it out or just skip it and go on.
- *If the patient stops, say,* "Look down this list, are there any other words you recognize?"

- *Provide them with the following list of words to read aloud:*
    - Diabetes
    - Exercise
    - Prevention
    - Asthma
    - Nausea
    - Fatigue
    - Adolescent
    - Anemia
    - Tetanus

- Bronchial

Assessment of nutrition literacy components (Bari, 2012)

I would like to know if you strongly disagree, disagree, are neutral, agree or strongly agree with the following statements.

1. **Food choices**

I'd like to know what would be important to you when choosing what food product to buy at the market/stop/kiosk for yourself. How important is:	Not at all important	Slightly important	Important	Extremely important	I don't know
1. Taste	☐	☐	☐	☐	☐
2. Price	☐	☐	☐	☐	☐
3. How healthy it is	☐	☐	☐	☐	☐
4. How easily available it is	☐	☐	☐	☐	☐
5. On packaged food – how important is the nutritional information on the label	☐	☐	☐	☐	☐

I'd like to know if you disagree or agree to these comments. When I buy myself a meal,	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1. I choose to eat until I'm full.	☐	☐	☐	☐	☐	☐
2. I choose to eat food from all the food groups.	☐	☐	☐	☐	☐	☐
3. I choose to eat just enough food to keep my body slim.	☐	☐	☐	☐	☐	☐
4. I choose to eat iron rich foods like beans, kontomire and animal foods.	☐	☐	☐	☐	☐	☐
5. I choose to eat fruits and vegetables with my meal.	☐	☐	☐	☐	☐	☐

1. **Knowledge**

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 – Reading the expiration date on food labels is important to health.	☐	☐	☐	☐	☐	☐
2- Eating too much fried food is bad for health.	☐	☐	☐	☐	☐	☐
3 – Eating a variety of different foods is good for health.	☐	☐	☐	☐	☐	☐
4 – Eating fruits can help protect the body from illnesses.	☐	☐	☐	☐	☐	☐
5 - I am familiar with the concept of a balanced diet	☐	☐	☐	☐	☐	☐
6 - I am familiar with Go, Grow and Glow foods.	☐	☐	☐	☐	☐	☐
7 - I understand what food I need to eat to have good level of iron in my blood.	☐	☐	☐	☐	☐	☐

8 - I understand what can happen to my body when I don't get enough iron from the food I eat.	☐	☐	☐	☐	☐	☐

1. **Functional nutrition literacy**

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 – When I feel ill, I know where I can go to get help.						
2 – When I want information about diet I know where I can go to get help.						
3 - If I have any questions about food and nutrition issues, I'm able to get information and advice from parents, teachers and health professionals.	☐	☐	☐	☐	☐	☐
4 – I find it difficult to understand the words used by nutrition, health and food experts.	☐	☐	☐	☐	☐	☐
5 – When I read an article about nutrition, food or diet I find words that I don't know.	☐	☐	☐	☐	☐	☐
6 – When I read information about nutrition, food or diet I find it difficult to understand.	☐	☐	☐	☐	☐	☐
7 – I find it difficult to know how I should change my diet when I get dietary advice from the doctor, nurse or the like.	☐	☐	☐	☐	☐	☐
8 – When I read information about nutrition, food or diet I need someone to help me understand it.	☐	☐	☐	☐	☐	☐
9 – I understand the nutrition information on packaged foods.	☐	☐	☐	☐	☐	☐

2. **Interactive nutrition literacy**

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 – I have been gathering information about diet from various sources that I think is relevant for me.	☐	☐	☐	☐	☐	☐
2 – I discuss diet with my friends, family and relatives.						
3 – If I see one of my friends or family eating poorly, I know what to say to encourage them to eat better	☐	☐	☐	☐	☐	☐
4 – I have changed my eating habits based on the information about diet that I have gathered.	☐	☐	☐	☐	☐	☐
5 – I look for opportunities to share with others (like family and friends) the things I know about nutrition and healthy eating	☐	☐	☐	☐	☐	☐
6 – I often read material about what makes up a balanced and healthy diet	☐	☐	☐	☐	☐	☐
7 – I take the initiative to talk with dietary experts (for example a doctor, nurse, teacher or the like) about healthy eating	☐	☐	☐	☐	☐	☐

8 – If my family were overweight and eating a high fat diet, I would tell them to change their eating habits.	☐	☐	☐	☐	☐	☐
9 – I have discussed my thoughts about diet to someone else (for example my friends, family, relatives, a doctor, nurse or the like).	☐	☐	☐	☐	☐	☐
10 - I am aware of the barriers I face to having a healthier diet	☐	☐	☐	☐	☐	☐

3. **Critical nutrition literacy**

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 – I would get involved in political issues targeted at improving people's diet in Ghana.	☐	☐	☐	☐	☐	☐
2 – I am willing to take an active role in measures aimed at promoting a healthier diet at my school.	☐	☐	☐	☐	☐	☐
3 – I expect my school to serve healthy food.	☐	☐	☐	☐	☐	☐
4 – I try to influence others (for example my family and friends) to eat healthy food.	☐	☐	☐	☐	☐	☐
5 – It is important for me that there be good selection of healthy food when I want to buy a snack or meal.	☐	☐	☐	☐	☐	☐
6 – I tend to be influenced by the dietary advice I read in my textbook, pamphlets, magazines etc.	☐	☐	☐	☐	☐	☐
7 – I tend to be influenced by the dietary advice I get from my family and friends.	☐	☐	☐	☐	☐	☐
8 – I trust all the various diets I hear of and read about in pamphlets, magazines etc.	☐	☐	☐	☐	☐	☐
9 – I manage my schedule in a way to be able to do exercise for at least a half an hour a day.	☐	☐	☐	☐	☐	☐
10 – When I read information about nutrition, diet or food, it is important to me that it is based on scientific evidence.	☐	☐	☐	☐	☐	☐

4. How much do you agree or disagree with each of the following statements as barriers to seeking information about nutrition, diet or food?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 – It's a lot of effort to get the information.	☐	☐	☐	☐	☐	☐
2 – I don't always trust the information I find.	☐	☐	☐	☐	☐	☐
3 – The information is difficult to understand.	☐	☐	☐	☐	☐	☐
4 – There is a lack of nutrition, diet or food information in Krobo.	☐	☐	☐	☐	☐	☐
5 – It takes a lot of time to look for the information.	☐	☐	☐	☐	☐	☐
6 – Once I know what to do to better my diet, it is difficult to access the healthy foods I want to eat.	☐	☐	☐	☐	☐	☐

7 – Once I know what to do to better my diet, its too hard to convince my parents to change the food we eat.	☐	☐	☐	☐	☐	☐
8 – Any other barriers? (please specify).						

5. In general, how much would you trust information about nutrition, diet or food coming from each of the following sources?

	Very weak	Weak	Neutral	Strong	Very strong	I don't know
1 – A doctor, nurse or any other health personnel	☐	☐	☐	☐	☐	☐
2 – Family	☐	☐	☐	☐	☐	☐
3 – Friends	☐	☐	☐	☐	☐	☐
4 – Textbooks	☐	☐	☐	☐	☐	☐
5 – Newspaper or magazines	☐	☐	☐	☐	☐	☐
6 – Television	☐	☐	☐	☐	☐	☐
7 – Radio	☐	☐	☐	☐	☐	☐
8 – Workers from an organization	☐	☐	☐	☐	☐	☐

Social cognitive measures related to adolescent dietary behaviors (Dewar, 2012)

1. **Self-efficacy scale**
   I'd like to know how much you agree or disagree with each statement.
   Whenever I have a choice of the food I eat…

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 - I find it difficult to choose food that *has not been* deep fried	☐	☐	☐	☐	☐	☐
2 - I find it easy to choose a healthy snack when I eat in between meals (eg. fruit)	☐	☐	☐	☐	☐	☐
3 - I believe I have the knowledge and ability to choose/prepare healthy snacks	☐	☐	☐	☐	☐	☐
4 - I find it difficult to choose healthy meals/snacks when I am out with my friends	☐	☐	☐	☐	☐	☐
5 - I find it easy to eat at least 3 servings of fruit each day	☐	☐	☐	☐	☐	☐
6 - I find it easy to eat at least 4 servings of vegetables/salad each day	☐	☐	☐	☐	☐	☐
7 - I find it easy to have healthy portion sizes during meals (eg. not eating till I feel full).	☐	☐	☐	☐	☐	☐

2. **Intentions scale**
   In the NEXT THREE MONTHS do you…

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 - …INTEND to eat at least 3 servings of fruit each day?	☐	☐	☐	☐	☐	☐

2 - …INTEND to eat at least 4 servings of vegetables/salad each day?	☐	☐	☐	☐	☐	☐
3 - …INTEND to choose food that has not been deep-fried whenever you have a choice?	☐	☐	☐	☐	☐	☐
4 - …INTEND to choose drinks and foods that are low in added sugar whenever you have a choice?	☐	☐	☐	☐	☐	☐
5 - …INTEND to eat healthier portion sizes during meals (eg. not eating till you feel full)?	☐	☐	☐	☐	☐	☐

3. **Situation scale**
   Can you tell me how much you agree or disagree with the following statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 - At home there are healthy snacks available to eat.	☐	☐	☐	☐	☐	☐
2 - At home there are healthy drinks available (eg. clean water, sugar-free drinks)	☐	☐	☐	☐	☐	☐
3 - At home fruit is always available to eat	☐	☐	☐	☐	☐	☐
4 - At home vegetables are always available to eat	☐	☐	☐	☐	☐	☐

4. **Behavioral strategies scale**
   I'd like to know how much you agree or disagree with each statement.
   In the PAST THREE MONTHS…

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
1 - …do you choose reduced-fat options when they were available (eg avoiding deep-fried foods)?	☐	☐	☐	☐	☐	☐
2 - …rather than choose sugary drinks such as soft drink, did you choose water?	☐	☐	☐	☐	☐	☐
3 - …did you leave food on your plate once you felt full during a meal?	☐	☐	☐	☐	☐	☐
4 - …did you prepare healthy snacks and meals for yourself that you knew had iron rich foods like with beans or green leafy vegetables?	☐	☐	☐	☐	☐	☐
5 - …did you try preparing new recipes for meals and snacks that you knew had iron rich foods like with beans or green leafy vegetables?	☐	☐	☐	☐	☐	☐
6 - …did you do things to make eating fruits and vegetables more enjoyable (like making a fruit salad)?	☐	☐	☐	☐	☐	☐
7 - …do you choose to eat a fruit as a snack?	☐	☐	☐	☐	☐	☐

5. **Social Support Scale**
   I'd like to know how much you agree or disagree with each statement.
   In the PAST THREE MONTHS how often …

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know

1 - …were fruit and vegetables available at home?	□	□	□	□	□	□
2 - …did your parents/caretaker make *healthy* snacks available (eg fruit)?	□	□	□	□	□	□
3 - …did your parents/caretaker prepare a *healthy* home-cooked dinner for you?	□	□	□	□	□	□
4 - …did your parents/caretaker encourage you to eat fruits and vegetable?	□	□	□	□	□	□
5 - …did you prepare *healthy* snacks or meals with your parents/caretaker?	□	□	□	□	□	□

6. **Outcome Expectations and Expectancies Scale**
   I'd like to know how much you agree or disagree with each benefit *and* how important each benefit is to you

1.a) Healthy eating can reduce my risk for some illnesses and diseases (eg. heart disease, diabetes, some cancers, etc.)	Strongly disagree □	Disagree □	Neutral □	Agree □	Strongly agree □	I don't know □
1.b) How important is reducing your risk for illness and disease **to you?**	Not at all important □	Slightly important □	Important □	Extremely important □		I don't know □

2.a) Healthy eating can help me to feel better physically.	Strongly disagree □	Disagree □	Neutral □	Agree □	Strongly agree □	I don't know □
2.b) How important is feeling better physically **to you?**	Not at all important □	Slightly important □	Important □	Extremely important □		I don't know □

3.a) Healthy eating can help me control my weight.	Strongly disagree □	Disagree □	Neutral □	Agree □	Strongly agree □	I don't know □
3.b) How important is controlling your weight **to you?**	Not at all important □	Slightly important □	Important □	Extremely important □		I don't know □

4.a) Eating fruits and vegetables will help my skin glow.	Strongly disagree □	Disagree □	Neutral □	Agree □	Strongly agree □	I don't know □
4.b) How important is having your skin glow **to you?**	Not at all important □	Slightly important □	Important □	Extremely important □		

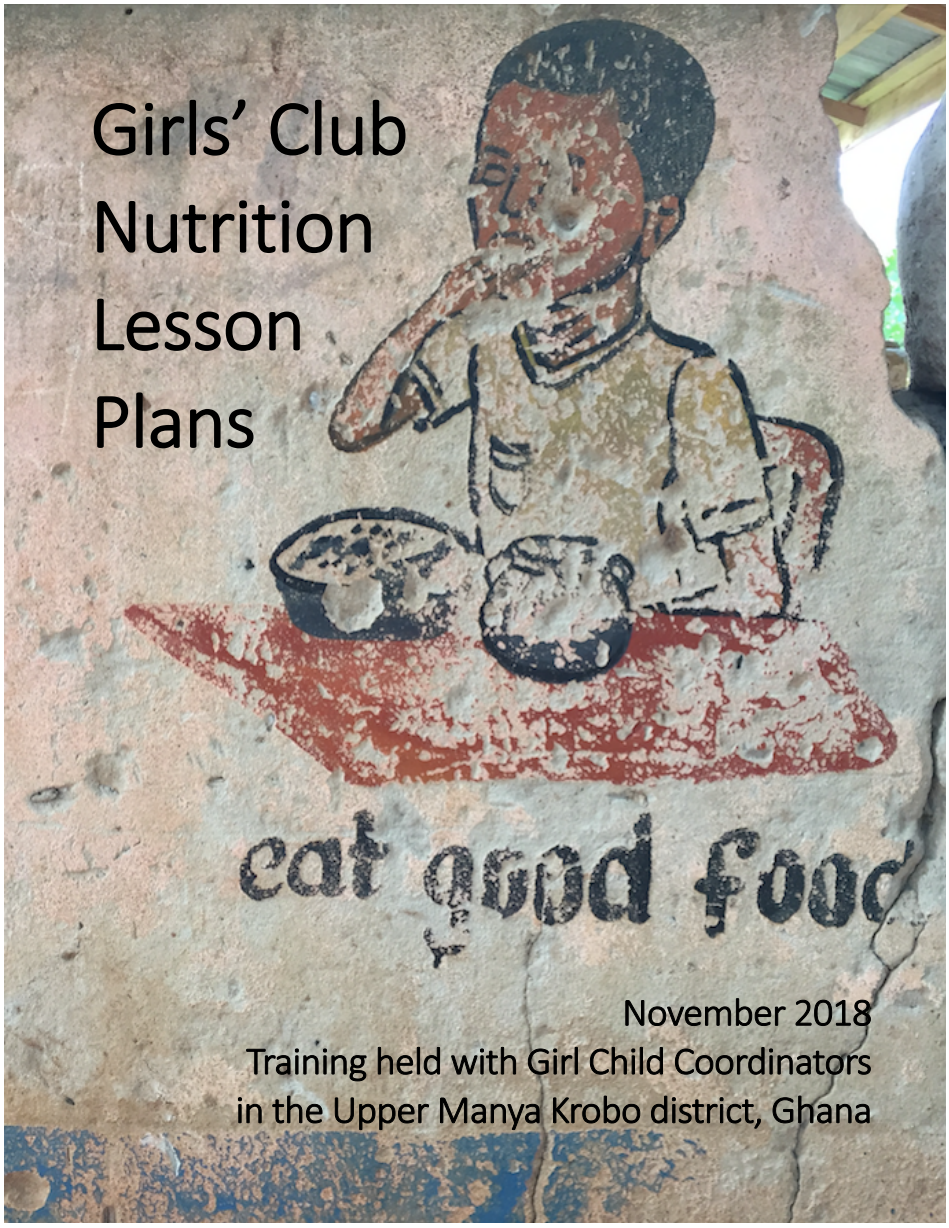
5.a) Healthy eating (eg. not skipping meals) can help to improve my concentration at school.	Strongly disagree □	Disagree □	Neutral □	Agree □	Strongly agree □	I don't know □
5.b) How important is improving your concentration at school **to you?**	Not at all important □	Slightly important □	Important □	Extremely important □		

6.a) Healthy eating can help me to feel more energetic throughout the day.	Strongly disagree □	Disagree □	Neutral □	Agree □	Strongly agree □	I don't know □
6.b) How important is feeling more energetic **to you?**	Not at all important □	Slightly important □	Important □	Extremely important □		

7.a) Eating iron rich foods will help prevent anemia.	Strongly disagree □	Disagree □	Neutral □	Agree □	Strongly agree □	I don't know □
7.b) How important is preventing anemia **to you?**	Not at all important □	Slightly important □	Important □	Extremely important □		

Appendix 8. Nutrition curriculum

The following is the nutrition curriculum that was compiled for the cluster randomized controlled trial.



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GIRLS' CLUB NUTRITION EDUCATION LESSON PLANS - INTRODUCTION

The aim of these nutrition education lesson plans is to assist teachers in fulfilling the three primary nutrition education objectives of Ghana Education Services' (GES) Life Skills Based School Health Education (2014). The three primary objectives are to help students "1) state the functions of nutrients, 2) describe the deficiency signs and symptoms of the various nutrients and 3) plan a balanced diet".

These lesson plans have been tailored to address adolescent girls' nutritional needs in Ghana. For example, teachers have been tasked by GES with reviewing the signs and symptoms of relevant nutrient deficiencies. Iron deficiency and iron deficiency anemia are the most common nutrient deficiencies in Ghana, especially among adolescent girls, and so it will be given special attention in these lesson plans. An additional lesson plan on nutrition for pregnant adolescents is included based on the recommendation of local key informants.

The content of these lesson plans come primarily from Adolescent Girls' Empowerment Program (AGEP)'s Nutrition Education Curriculum (Population Council, 2014) and from World Vision – Nutrition Links' Health and Nutrition Educational Topics for Adolescent Girls at Upper Manya Krobo District Manual (World Vision, 2015) as well as guidance from the Nutrition Department of Ghana Health Services.

The lesson topics are as follows: 1) adolescent nutrition, 2) balanced diet, 3) anemia in adolescent girls and 4) nutrition for pregnant adolescents.

LESSON 1 – ADOLESCENT NUTRITION

OBJECTIVES

- To understand the importance of good nutrition for good health
- To understand the functions of nutrients

KEY "TO DO" MESSAGE

- **Eat a variety of food to be healthy**

SUPPORTING MESSAGES

- What we eat and drink is made up of nutrients.
- Nutrients are what our body needs to stay healthy.
- We should eat a variety of foods to get a variety of nutrients.
- Instead of dieting girls should eat a balanced diet with more fruits and vegetables and exercise regularly.

MATERIALS

- Coloured crayons & paper, blocks

PREPARATION

- Collect blocks or stackable objects that can make a small pyramid or wall. Or draw a pyramid made of different coloured blocks on paper or chalkboard

TIME - 30 MINUTES

ACTIVITIES

1. Introduction (5 minutes)
2. Building blocks of nutrition (10 minutes)
3. Eat a variety to be healthy (10 minutes)
4. Four Corners (20 minutes)
5. Wrap up (5 minutes)

1.INTRODUCTION (5 minutes)

Say: Welcome to the learning session on the foods we eat and what we get from them. What we get from food is called nutrition.

We are meeting together in our Girls' Club to support each other, and learn about how to make good decisions in our lives. We are now going to learn about food and nutrition and how to make healthy food choices. This is because food and nutrition are important to our health. If we have good nutrition we can grow strong and stay healthy for the rest of our lives.

What we eat affects every part of our lives. It can make us feel good or sick, it can help us grow, and it can give us energy to help keep us healthy.

2.BUILDING BLOCKS OF NUTRITION (10 minutes)

Explain: In this activity, we are going to learn about the role of food in the body. What do you think nutrition means?

Action: Listen to their different answers, but do not give approval or denial. This will allow you to have a better understanding of the girls' knowledge base.

Say: *What we eat or drink is broken down into tiny pieces called nutrients (food elements) that the body needs*. The nutrients give our bodies' energy and other benefits so that we can walk, run, work, play, grow, and fight sickness.
To have good nutrition and remain healthy we must eat a variety of foods each day.

Action: Create or draw a pyramid made of different coloured blocks.

Ask: What do these building blocks have to do with food? What would happen if one piece is taken out of the block creation? Or if all the pieces of one colour – yellow, blue, green or red were removed?

Action: If you made a pyramid block creation, remove one block and have the wall fall apart.

Say: The body is made up of many smaller pieces and each of them has a specific role to play in the body.
Like building blocks that are used to make a wall, different types of food contain different nutrients called vitamins, minerals, proteins and carbohydrates that the body needs to stay strong and healthy. The body uses these nutrients to build our muscles, bones, body, hair, nails, cells, tissues, and many more parts and keep them strong and healthy.
These building blocks (nutrients) come in different colours and each colour has a special job in the wall.

3. EAT VARIETY TO BE HEALTHY (10 minutes)

Say: What if all the blocks in the pyramid would be the same colour?

Say: Staple foods such as fufu, kenkey, tuo zaafi, akple , banku are good because they provide energy and some nutrients. But a good meal must provide other foods that the body needs to function properly. Even though these are usually eaten in smaller quantities than the staple food they are as important. *Our meals should be much more than just staple foods like fufu, banku or kenkey.*

Explain: Different foods do different things in the body, for example:
- Some foods *give energy* (eg. fats and oils, kenkey, rice, etc.)
- Some foods *build blood* (eg. meat, fish, dark green leafy vegetables)
- Some foods *help us have good eyesight* (eg. palm oil, carrots, pawpaw)
- Some foods *strengthen the body's ability to fight disease* (eg. fruits and vegetables, oily fish, wholegrain cereals).
- Some foods help *build strong bones* (eg. milk and milk products, chewable bones in fish or meat).

Imagine what would happen to your body if we didn't eat one or more of these types of foods. We should eat a variety of foods to get a variety of nutrients. When we do that we will have a balanced diet. A balanced diet is when we eat foods that have all the nutrients the body needs to function well.

Say: Some family members may have different food needs because of their age, whether they are male or female, how active they are whether they are pregnant or breastfeeding.

Ask:
What kinds of meals should an adolescent girl like you be eating?
Why can't a girl like you just eat whatever she feels like eating?

Aside from the first year of life, adolescence is the stage in life where the most phenomenal growth occurs. During adolescence, the total nutrient needs are higher than during any other time in the lifecycle. With an increase in nutrient needs typically comes as increase in appetite. It is therefore important that food choices are made carefully to promote good health and avoid potential issues that can arise from poor nutrition such as high cholesterol levels, high blood pressure and low iron levels which can lead to diseases like Anemia, heart diseases, diabetes and cancer. Since nutrition and physical growth are so related, the importance of optimal nutrition for full growth potential cannot be overstated. With the right nutrition, adolescents can thrive both physically and mentally.

4. ACTIVITY: FOUR CORNERS (20 MINUTES)

Learning objectives:

- To determine if participants have a good understanding of what healthy and unhealthy eating habits are.
- To reinforce healthy eating habits learnt

Tell the participants that they will do an exercise called 'Four Corners'. The rules are that you will narrate a case with a problem and provide them four options to resolve that problem. The four options will be written on separate pieces of paper and put up in four corners or four people who can read the options will be placed in the four corners to read it to the others. The participants will have to listen to the case carefully and chose the option they find most appropriate and go and stand in that corner. While doing so, no one is allowed to talk to anyone else or say anything about their opinion till you give the next instruction. Ma-Naki is a 14-year-old girl. She likes to eat. Ma-Naki likes packaged snacks like plantain chips and carbonated drinks like coke. She also likes sweets a lot. Every day Ma-Naki's mother gives her some pocket money when she is going to school to buy lunch. Instead of buying a proper lunch, Ma-Naki has been spending that money on eating unhealthy food from the market. Her mother has also observed that Ma-Naki doesn't eat her meals at home properly. She finds her a bit lazy and most of the time sitting under a tree doing nothing much. She tries to talk to her, but she takes offence and says that it is her pocket money and she should be free to do what she wants with it. Her mother gives up. One day when Ma-Naki returns from school she complains of heartburn. Her mother gives her some cold water to drink and tells her to rest. While clearing Ma-Naki's room her mother sees packets of chips and other fried stuff in her school bag. She is very angry and doesn't know how she can help Ma-Naki get rid of this unhealthy eating habit.

- Options/Corner 1: Mother needs to be a little more patient with Ma-Naki while being strict and talk to her on what it means to eat well.
- Options/Corner 2: Mother should take Ma-Naki to a doctor, counsellor or Youth centre.
- Options/Corner 3: Mother should stop giving Ma-Naki pocket money and let her take food from the house to school.
- Options/Corner 4: Any other option (participants are free to have opinions other than the three mentioned).

Now ask the participants to choose an option and quietly stand in the corresponding corner.

- Ask them to share the reason for their choice with the other participants in their own corners but not with the others.
- In case a corner has only one participant, you should ask the participant to share his reasons with you.

- Tell the corners/groups that one person from the group will later share the reasons with the larger group.
- Give 5 minutes for this. You should not give any opinion during the exercise or even later and should avoid appreciating any response by saying 'good' or 'well said'. Such expressions create inhibitions or barriers among participants if they have an opinion different from what is being appreciated or expressed by you.
- Then invite each group to present its reasons with the larger group while standing in the corner itself.
- Once all groups have shared their reasons, ask if any participant wants to change his/her stand and hence the corner. Give 2 minutes for that. There may be some who change or there may be no change. Thank the participants and ask them to go back to their seats.
- [These exercises do not aim to establish right or wrong but try to help the participants identify their own values related to the subject and think of a positive solution to the problem. They may be right or wrong, but sharing gives them an opportunity to learn about other opinions that may trigger a change at a later stage.]
- Tell participants that Ma-Naki's story is not unique. Ask them if they have experienced something like this. Inform participants that overeating or eating a particular food in excess is also a major problem of malnutrition.

5. WRAP UP (5 minutes)

Action: Ask the girls to summarize what they have learnt. Fill in any key points missed.

- What we eat and drink is made up of nutrients.
- Nutrients are what our body needs to stay healthy.
- We should eat a variety of foods to get a variety of nutrients.
- A fast growing adolescent body needs to eat highly nutritious meals to keep up with the growth and avoid health issues
- **Make sure to emphasize the key TO DO message**:
  Eat a variety of foods to be healthy.

Ask for final questions or comments.

NOTES

_____
_____
_____
_____
_____
_____

LESSON 2 – A BALANCED DIET

OBJECTIVES

- To understand the benefit of eating a variety of foods
- To understand how to plan a balanced diet

KEY "TO DO" MESSAGE

- **Eat Go, Grow, Glow foods to be healthy.**
- **Eat fruits and vegetables with every meal *to glow.***

ADDITIONAL IMPORTANT MESSAGES

- **Go with energy giving foods** like rice, cassava and plantains.
- **Grow with body build building foods** like animal foods, beans and nuts.
- **Glow with protective foods** like fruits and vegetables.

MATERIALS

- …

TIME - 1 HOUR

ACTIVITIES

1. Review (5 minutes)
2. Go, Grow and Glow foods (25 minutes)
3. From the market/garden to the kitchen (20 minutes)
4. Wrap up (10 minutes)

1.REVIEW (5 MINUTES)

Say: Last time we spoke about nutrition we said that:

- What we eat and drink is made up of nutrients.
- Nutrients are what our body needs to stay healthy.
- We should eat a variety of foods to get a variety of nutrients.
- A fast growing adolescent body needs to eat highly nutritious meals to keep up with the growth and avoid health issues.
- **Eat a variety of different foods to be healthy.**

2. Go, Grow, Glow Foods (25 minutes)

Explain: In this activity, we are going to learn about making balanced meals with the right kinds of food eaten together. A balanced diet is when we eat foods that have all the nutrients the body needs to function well.

Explain: We shall now talk about meal planning using the *go*, *grow* and *glow* guiding principle. This idea emphasizes the importance of eating variety of nutrients. Food items can be grouped according to the main nutrients they contain. There are three main food groups:

- Group 1: Energy giving foods (**Go foods**).
- Group 2: Body building foods (**Grow foods**).
- Group 3: Protective foods (**Glow foods**).

Each of the three food groups perform a particular function in the body and work together, but the body will not function properly if it lacks any of the three food groups for a period of time. It is therefore, important that every meal provides a different mixture of nutrients from the three food groups.

1.GO FOODS (ENERGY GIVING FOODS)

Go foods are starchy and fatty foods that mainly provide energy and fuels the body to move about and be active, to keep the heart pumping blood, the lungs breathing, and the mind active, etc. These foods help the body to have energy to run, play, work, think and generally to keep the body in good working condition.

Examples of energy giving foods: Cassava, yam, plantain, maize, millet, rice, sorghum, palm fruit, shea nut and oils.

2.GROW FOODS (BODY BUILDING FOODS)

Grow foods are foods from mostly from animal sources and plant sources (like beans and groundnut) and provide nutrients that are needed to build and maintain muscle, blood, skin and bones and other tissues and organs in the body.

Examples of body building foods: All types of meat, fish, eggs, milk and milk products. Some plant foods such as those from the bean family e.g. cowpea, soya bean, bambara beans, and nuts and oilseeds like groundnuts, cashew nuts, 'agushie' (melon seeds), and sesame seeds also perform growth functions in our bodies when eaten.

10

3.GLOW FOODS (PROTECTIVE FOODS)

Glow foods are foods that when broken down will protect the body from infection. These nutrients called vitamins and minerals are required in the body in small quantities compared to the Go and Grow foods and are mainly found in fruits and vegetables. Glow foods keep us healthy and help the hair, eyes and skin to look shiny or to "glow".

These foods include dark green leafy vegetables such as aleefu, ayoyo, and nkontomire; tomatoes and carrots; and fruits like mangoes, oranges, and pawpaw.

Action: Demonstrate how a nutritious meal is achieved by including ingredients from each of the three food groups. Examples of healthy combinations from the above three food groups include: 1) Groundnut soup with fish, banku and orange; and 2) rice with bean stew, tuna and pineapple.

Ask: Why is it so important to eat different kinds of foods from each of the food groups? What do you think might happen to a girl who eats only two kinds of food at every meal?
Wait for a few replies. Prompt the quiet girls to say something too.

Explain: It is important to enjoy foods from each of the food groups because different foods provide us with different amounts of key nutrients.

Ask: How can you be sure that you are getting the nutrients needed?

Explain: If we eat a variety of foods from all the food groups, we will get a mixture of nutrients required by the body for growth and strength. It is important to eat a variety of foods from each of the food groups in order to GO, GROW and GLOW!

Remember in our last session we said we need to **eat a variety to be healthy. By variety we mean, we need to eat Go, Grow and Glow foods with every meal.**

Here is our new challenge – Make sure we **eat fruits and vegetables with every meal *to glow***

3.FROM THE MARKET/GARDEN TO THE KITCHEN (30 MINUTES)

Explain: We will now learn about how to choose and combine foods for healthy meal planning.

Action: Divide the girls into smaller groups. Provide paper and ask them to use a pen or pencil to draw.

Say: Take an imaginary trip to the market or garden to buy or harvest food that you will use to prepare lunch or supper. Ask them to draw ingredients they would need to make a nutritious meal. Make sure you add ingredients that will help you “glow”.

When you are done with your trip to the market or garden, each group will present the meals they planned to prepare and will show the picture they have drawn. The groups will also explain why you have chosen each kind of food.

Action: When one group presents, ask the other girls what they think of the food chosen and the meal planned by that group.

Make corrections where need be and end by making concluding remarks.

4. WRAP UP (5 MINUTES)

Action: Ask the girls to summarize what they have learnt.
Fill in any key points missed.

- **Eat Go, Grow and Glow foods to be healthy.**
- **Go with energy giving foods** like rice, cassava and plantains.
- **Grow with body build building foods** like animal foods, beans and nuts.
- **Glow with protective foods** like fruits and vegetables.
- **Eat fruits and vegetables with every meal *to glow.***

Make sure to emphasize the key message:
Eat fruits and vegetables with every meal *to glow*.

Ask for final questions or comments.

NOTES

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LESSON 3 – ANEMIA IN ADOLESCENT GIRLS

NOTE TO TEACHER

Adolescents are at a great risk of anemia because they grow quickly, and they do not eat enough food with an important mineral called iron to keep up with their quick pace of growth. Adolescent girls who start their menses need more iron because they are at risk due to blood loss during menstrual periods. In some cases, pregnancy can also lead to anemia. Girls who do not eat sufficiently or lose a lot of weight due to illness are also at risk of not eating enough iron.

OBJECTIVES

- To understand what iron deficiency anemia is and what causes it
- To identify the signs and symptoms of anemia
- To identify the food sources that can prevent anemia

KEY "TO DO" MESSAGE

- **Eat iron rich foods like beans, dark green leafy vegetables or animal foods each day to avoid anemia.**

ADDITIONAL IMPORTANT MESSAGES

- Anemia is a health condition when the blood doesn't have enough iron.
- The signs and symptoms of anemia are fatigue, pale skin, shortness of breath and feeling weak.
- Iron-deficiency Anemia is an avoidable condition which can be prevented by what we eat.
- Eating foods high in iron content such as beans, dark green leafy vegetables and red meats regularly can help prevent Anemia
- To help the body absorb plant-based sources of iron, we should also eat foods rich in vitamin C like oranges, mangoes and tomatoes.

MATERIALS

-

TIME - 1 HOUR

ACTIVITIES

1. Review (5 minutes)
2. What is Anemia? (15 minutes)
3. Story of Dede (25 minutes)
4. What should I eat? (10 minutes)
5. Wrap up (5 minutes)

1.REVIEW (5 MINUTES)

Say: In the first lesson together about nutrition we learned about how important nutrition is for our health. We learned that:

- The food we eat is broken down into tiny pieces called nutrients used for body building. The nutrients give our bodies energy and other benefits so that we can walk, run, work, play, grow, and fight sickness.
    - Eat a variety of food *to be healthy.*
- Our bodies need healthy foods to have energy, to be strong, alert, and protect us from illnesses. Good nutrition is achieved by eating different kinds of foods in the right amounts.
    - Eat GO, GROW, and GLOW foods.
    - Eat fruits and vegetables with each meal *to glow.*

2. WHAT IS ANEMIA? (10 MINUTES)

Explain: In this activity we are going to learn about *anemia*; a health problem that affects many people, especially adolescents' girls.

Ask: Does anyone know what anemia means? Wait for a few replies.

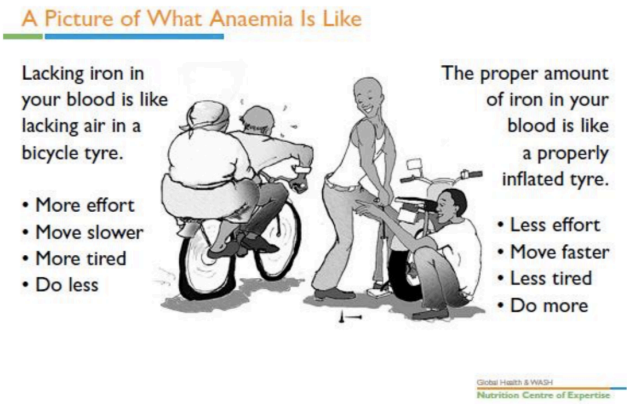
Explain: Anemia is a health condition that occurs when the blood does not have enough of one very important nutrient we get from food called iron. Iron is an important nutrient for transporting oxygen in the blood and preventing Anemia. When you don't have enough iron in your blood, you are anemic.

With the rapid growth during adolescence, the need for iron increases, and this is especially so among girls who are menstruating. Iron needs are the highest in females after the onset of menstruation. Adolescent girls can become anemic because they don't eat enough of the right kinds of food and because of their menses. When girls have their menses, the amount of iron in their blood can drop through blood loss.

When you are anemic and have too little iron in your blood, you can feel **very weak and tired**. You can also feel **dizzy** from time- to-time. You may also have **pale palms, feel breathless, experience headaches and may be too weak to do physical work.**

ANEMIA - TYRE ANALOGY

Anemia is like not having enough air in your tyre.



Source: WV Reducing Childhood Anaemia

Tyre Analogy	**Iron-Deficiency Anaemia**
Air is needed in tyres in order to make them go around properly.	Iron is needed in the blood to make it function properly.
Adequate air in tyres allows people to carry heavy loads, move faster, and get more accomplished.	Having adequate iron in your blood gives you more energy, allowing you to be more active and productive.
Adequate air is especially needed when the tyres are supporting heavy loads.	At different times in the lifecycle more iron is needed in the blood – for example, during childhood and pregnancy.
Air can be lost from the tyres (through a slow leak or a nail puncture).	Adolescents may lose iron if they have bloody stools, frequent diarrhoea, malaria, or other illness.
Having enough air in the tyre is important regardless of whether the tyre is on a bike, a donkey cart, or a fancy motor bike.	Iron deficiency Anaemia can affect all ages and both men and women – although women and adolescents are especially affected.
Tyres must be pumped up regularly.	Iron stores in the blood must be constantly replaced.

WHAT ARE THE SIGNS AND SYMPTOMS OF ANEMIA?

Adolescents with Anemia:

- Lack strength and are often tired and weak
- Have difficulty learning and focusing at school
- Tend to be more ill-tempered than normal
- Feel dizzy or experience headaches
- Feel breathless or have a racing/irregular heart beat
- Pale skin – pale palms

3. THE STORY OF DEDE (30 MINUTES)

Present the story of Dede given below:

Dede Tetteh, a 14-year-old student in JSS 3, is very popular in her school as a fast runner. Last year she won the 1,000 meters run in the district level inter-school games. Dede's teacher tells her that she will become very popular one day and if her performance continues to be good, she will represent her state in the national games. In three months the state level Annual Games begin in the capital city. The school has high hopes and expects to be in top three on overall performance. Dede will represent her school for the 1,000 meters and 100 meters relay.

But for the last few months Dede has been feeling tired and does not want to go for practice school hours. The sports teacher is very angry with her for not being regular for practice. One day he tells her that she is mature enough to understand her responsibilities and that she is letting her team and school down. He also tells her that he will not listen to any more excuses and will replace her with another more deserving girl.

Dede doesn't want to be taken off the team, so she comes for practice. She starts running and completes her first round but slows down in the second round. The teacher observes that she is not able to perform as she did in the past. She is exhausted and gives up after two rounds. Her friends and teacher try to build her confidence and ask her to complete the distance. But Dede cannot complete even half the distance. Her teacher is concerned. The sports teacher discusses the matter with her class teacher. The class teacher informs him that Dede's performance in her class work has also worsened. The sports teacher feels he should talk to her parents.

Ask the following questions and discuss them as a group

Discussion Points:

1. What do you think is the reason for Dede's poor performance in games?
2. What did Dede's teacher notice?
3. What should the teacher do to help Dede?
4. Do you know of any people who have complained of tiredness or dizziness like Dede?
5. What should adolescents do whenever they feel tiredness or dizziness?

Explain the following to the girl:
Dede's poor performance may be due to not eating well and the weakness that results. She may have an infection if she has fever too. Her tiredness could also be linked to infections like malaria, worms or conditions related to the menstrual cycle, if she experienced any of these recently. The teacher should have inquired about Dede's health even earlier as she has not been well for a few months now. The teacher should talk to Dede and her parents and refer her for a check-up at the nearest health facility.

Taking Dede's story further, narrate the next part of the story:
The teacher visits Dede's house and finds that Dede's parents are both farmers who grow cassava and process it into gari to sell at neighboring markets. Dede has to help her parents a lot in order for the family to produce enough gari for sale so that they can make ends meet. On good days where they are able to sell the gari, Dede's family is able to eat a relatively nutritious meal for dinner, but more often than not when sales are not good, the family has to eat some of the gari with ground pepper mixed with a bit of oil for dinner. She also helps to look after her three younger siblings and does a lot of household chores as well. Her mother says that she is proud of her adolescents, especially Dede, and feels bad that Dede has to work so hard to support the family.

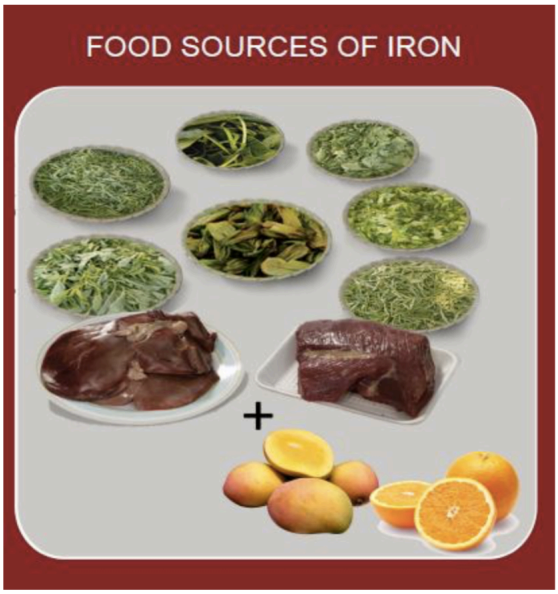
After finding out more about Dede's life, the teacher requests Dede's parents to get her examined by a doctor. They are scared and cannot understand why their healthy daughter needs to be taken to a doctor but agree. At the health centre, the doctor suggests a blood test and Dede is found to be anemic.

Discussion Points:

1. Why did the teacher ask Dede's parents to take her for a health check-up? Is there anything wrong with the schedule followed by the family?
2. Do you think Dede has been eating well? Why?
3. What is Anemia? Do you think you may have Anemia?

4. What should I eat? (10 minutes)

Explain: We can prevent anemia by making the right food choices. In order to prevent anemia we have to eat food with enough iron.



Explain: Blood has enough iron by eating good food with lots of iron such as beef, pork, chicken, fish, eggs, beans, groundnuts, and dark green leafy vegetables such as Ayoyo and Aleefu

Animal- based sources of iron (e.g. meat, poultry, and fish) are more easily absorbed by the body than plant-based sources of iron (e.g. dark green leafy vegetables, soybeans).

For better absorption, the ***plant-based*** sources of iron should be eaten with foods high in vitamin C such as oranges, mangoes or tomatoes. For example, the iron from a meal like ayoyo stew will be absorbed better because of the presence of tomatoes in the stew alongside the dark green leafy vegetable.

Explain: It is important to eat foods that have lots of iron in them at every meal. Eating plenty of dark green leafy vegetables in addition to eating fruits after meals can give you enough iron to keep you strong and healthy. You can also occasionally eat a small amount of meat, fish or eggs added to foods such as beans.

5. Wrap up (10 minutes)

Action: Ask the girls to summarize what they have learnt. Fill in any key points missed.

Key Message: Adolescents need to make healthy food choices to prevent anemia. This includes eating foods with lots of iron at every meal, including dark green leafy vegetables, beans, fruits, meat and fish.

Key TO DO Message:
Eat iron rich foods like beans, dark green leafy vegetables or animal foods each day to avoid anemia.

Ask for final questions or comments.

LESSON 4 – NUTRITION FOR PREGNANT ADOLESCENTS

Note to Teacher: **This session discusses the importance of nutrition and other issues surrounding adolescent pregnancy.**

FACILITATORS' NOTES: Sufficient energy is a primary dietary requirement of pregnancy. If energy needs are not met, available protein, vitamins and min- erals cannot be used effectively for various metabolic functions. Energy requirements are greater for pregnant adolescents than their non-pregnant peers.

OBJECTIVES

- To understand the importance of good nutrition in pregnancy
- To understand the factors influencing nutritional needs of pregnant adolescents
- To outline eating behaviours and their implications in pregnant adolescents

MATERIALS

- Flipchart and markers or chalk board and chalk, sticky stuff or masking tape

TIME - 1 HOUR

ACTIVITIES

1. Food and nutrient needs in pregnancy (30 minutes)
2. Common eating behaviours in pregnant adolescents (30 minutes)
3. Wrap up (10 minutes)

1.FOOD AND NUTRIENT NEEDS IN PREGNANCY (30 MINUTES)

Explain: We are now going to discuss food and nutrient needs in adolescent pregnancy. Remember that nutrients are the parts of food that are good for us, including protein, vitamins, minerals and carbohydrates.

What do you think are the food and nutrition needs for pregnant adolescents?

Wait for a few replies.

Explain: Getting enough of the right kinds of foods is important during pregnancy so that girls have enough energy and nutrients so that the baby grows nicely. This is true for all women, but adolescent girls need more nutrients because they are still growing as well. To get enough energy, protein, vitamins and minerals during pregnancy requires that the adolescent girls eat more and the right kinds of foods.

Getting enough iron is of special concern in pregnancy. This is because the need for iron increases in pregnancy due to the food and nutritional needs of the adolescent girl and the baby. The body's need for iron during pregnancy increases as the pregnancy goes on. When an adolescent girl does not have enough iron, anemia develops. Not having enough iron during the first 6 months of pregnancy can be harmful to the mother and the baby. It can lead to early delivery of the baby or the baby being born at a low birth weight.

Action: Facilitate a discussion using the food pyramid to remind the girls of the key messages on healthy food choices.

Say: Like we discussed before, healthy food choices are very important for pregnant adolescents. Remember to increase the amounts and kinds of food so that both the mother and baby grow strong and healthy.

Action: Divide the girls into 3 groups. Give them decks of food picture cards. Ask them to identify foods which are good for pregnant adolescents. Allow them five minutes to complete the task then ask them to return as a group and share their responses, giving reasons for the choices. Ask the other girls whether they agree or disagree and give reasons for their answer.

Ask: What are the key health care needs for pregnant adolescents?
Wait for a few replies.

Explain: It is best for pregnant adolescents to start attending ante-natal care (ANC) at the health facility as soon as they know that they are pregnant. At the health facility they will be provided with the necessary health care, information, and will be given iron and folic acid tablets. Folic acid, like iron, is another very important nutrient for pregnant girls. At the health facility girls will also learn more about food and nutrition to help both them- selves and the baby.

2.COMMON EATING BEHAVIOURS IN PREGNANT ADOLESCENTS (30 MINUTES)

Action: Ask for two volunteers to play the role of Jelita, a pregnant adolescent and Chilinda her friend. Call them aside for a briefing on the role play. Give them their roles in the play as follows:

Jelita: Jelita shares her experiences with Chilinda saying, "Lately I have been feeling sickly and weak. I often don't eat as I don't want to grow big so that people will see that I am pregnant. Instead I snack on crisps, Fanta and bubble gum. I spend the day at the market where I keep myself too busy and eat a lot of chips".

Chilinda: Chilinda is to listen and give good advice about healthy eating to her friend Jelita based on what she has learned about food and nutrition.

Explain: In this activity we are going to talk about common eating behaviours in pregnant adolescents.

Action: When they are ready ask both Jelita and Chilinda to come forward and role play. Ask the rest of the girls to be attentive to the role play. At the end of the role play, ask the girls, "What did you see and learn from the role play? Did Chilinda help her friend improve her nutrition?"

Explain: In the role play we heard that Jelita was pregnant and skipping meals, preferring to snack on foods high in fat or sugar without little nutritional value. Jelita was too busy to make good food and ate a lot of fast food. Typical of adolescents, Jelita lacked a stable supply of healthy foods and perhaps had limited food preparation skills and facilities.

Ask: What are some of the ways that Chilinda tried to help her friend Jelita? What kinds of good advice about healthy eating did she give? Is there anything she missed?
Wait for a few replies.

Explain: Chilanda tried to teach her friend that she needs to eat enough of and the right kinds of food at every meal. She points out that pregnant adolescents need to eat healthy because they and the baby are growing. The pregnancy places extra needs on the adolescent's body. To eat the right way, Jelita needs to get food from different food groups, making sure to eat staple, GO, GROW and GLOW foods to get enough nutrients. Also, Jelita needs to know that if she doesn't eat enough iron she may become anemic which is a danger to both the girl and her baby. If Jelita is losing weight or feeling tired all the time, she should go to the clinic.

3. WRAP UP (10 MINUTES)

Action: Ask girls to say what they have learnt in today's session. Fill in any key points missed.

Key message: Pregnant adolescents have increased nutrient needs to allow for growth and development for both the baby and the mother. Not getting enough food and the right kinds of food can be dangerous for both the girl and her baby.

Ask for final questions or comments.

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Appendix 9. Intervention protocol

This Appendix presents the intervention protocols used in creating the first and second participatory videos (**Figure A9.1** and **Figure A9.2** , respectively) and the steps used in planning the video screenings (**Figure A9.3**).

VIDEO ONE- Intervention Activities

Intervention Schedule

Time Interval (in minutes)	Activity
10	Introduction
40	Name Game
20	Nutrition Topic Review
30	Margolis Wheel
30	Problem Tree
30	Brainstorm + Voting
60	River of Life
30	Framing + Tripod
20	Storyboard
120	Filming + Consent
20	Paper Edit

Margolis Wheel

1. What does it mean when someone doesn't eat a balanced diet?
2. What does a balanced diet look like in your home
3. What happens if you don't eat a balanced diet
4. What happens if you do eat a balanced diet. What will you look and feel like if you always eat a balanced diet?
5. What will you do if you find out your friend doesn't eat a balanced diet? What would you say to encourage them to have a balanced diet?

6. What prevents you from eating a balanced diet at school?
7. We've talked about what prevents us from getting a balanced diet at school. How would you overcome this obstacle at school?

8. What prevents you from eating a balanced diet at home?
9. We've talked about what prevents us from getting a balanced diet at home. How would you overcome this obstacle at home?

10. How will you improve access to Go, Grow, Glow foods at your school? and home?
11. How will you convince your parents to change your diet at home.

Figure A9.1 – Participatory video 1 intervention activities

Problem Tree

1. Review the elements in the tree - Cause, Effects, Obstacles, Solutions
2. Put attention on the obstacles
    a. Remind them it is a safe space without judgement
    b. Examples of the obstacles that are most important/ relevant in our community
    c. Explain that we want to make videos that will help them teach and influence others
    d. Share examples in their own life of obstacles (and if possible, how they overcome it)
    e. To vote – get rock (1 rock per girl) and vote
3. Once obstacle is chosen then discuss the details of the solutions

River of Life

1. Review story of Ma-Naki and the outline of the river of life for that story.
2. **Objectives for video 1** – Topics that should be covered in a River of Life
    a. What is a balanced diet
    b. What makes up a balanced diet
        i. Define Go, Grow, Glow foods and give examples
    c. What happens when you have a balanced diet / what happens when you don't have a balanced diet
    d. What prevents us from getting balanced diet – The story should have an obstacle or problem to overcome
    e. What are the solutions
    f. Make sure the story has a problem and solution.
3. Draw out the story first.
4. Then introduce the concept of a river and that we can tell the story in the form of a river.
5. For each scene in the story, ask how the protagonist would feel, what are the emotions in the story. How would the river look like depending on the emotions/situation in the story.

VIDEO TWO – Intervention Activities

Intervention Schedule

Time Interval (in minutes)	Activity
20	Introduction
20	Reflection of Video One Screening
20	Nutrition Topic – Lesson 3
15	Appearing/Disappearing Game
40	Margolis Wheel
5	Show Appearing/Disappearing video
60	Problem Tree/ Consultation/ Vote
60	River of Life
30	Review Framing/ Angles/ Filming tips
15	Storyboard
	Filming

Introduction

- This time will be spent making sure the girls advance in their **understanding of the purpose of being part of the participatory video intervention.**

We are researchers. *Wo ji ne se kpa lihi.*

- Previously we have consulted about obstacles for balanced diet in your community. In each school, our consultation gave us unique answers and unique solutions.
- A researcher from outside the community would not have easily come to your conclusions. You are very special researchers in your community – with a unique view and perspective.
- Some adolescent girls get anemia and some girls don't.
  Together, we are a research team, and together we want to find out what is the reason why girls in (name of community) get anemia.

We are teachers. *Wo ji ts) lihi.*

- We have benefitted from the nutrition education.
- We have benefitted from consulting together about our community and identifying issues
- We have a responsibility to teach others what we have learned.
    1. Why? (So that we alone don't benefit. So that we can make more change for the better, like getting fruits in the canteen etc.)

Figure A9.2 – Participatory video 2 intervention activities

We are agents of change. *K3 maa gu wa n)), tsakemi maa ba.*

- We are making the videos in order to see change.
    1. For example, with the video on balanced diet, what change are we planning to see?
- How can we continue to influence the girls in the girls' club and the rest of the school to change their behaviour?
    1. You want to see your friends eating balanced diet. What should you yourself be doing?
    2. For example: If you teach your friends to not eat sweets, but all you do is eat sweets yourself. How do you think they will react?
    3. *"Whoso ariseth to teach the Cause of his Lord, let him before all else teach his own self that his speech may attract the hearts of them that hear him."*
    4. Our teaching will have power and influence if we do what we teach.

Can someone summarize what we just discussed:

1. **We are researchers.**
2. **We are teachers.**
3. **We are agents of change.**

Reflection of Video One Screening

- Can you recall what you've learnt from all the activities we did for the first video?
- What did you want the audience to think or do after they watched the video?
- After the video, what has been your observations:
    - In your own thoughts and behaviours?
    - In your friends' thoughts and behaviours?
    - In your school?
    - In your home?

Margolis Wheel

1. What is anemia?
2. What are common beliefs you've heard in your community about the cause of anemia?
3. What is the cause of iron deficiency anemia?
4. Why are adolescent girls at risk of having anemia?
5. What are common beliefs you've heard or seen about things you need to do or eat when you have your menstruation?
6. What other beliefs do you or your family have concerning the food you eat. For example name of leaf juice is believed to heal malaria. Is there any beliefs you know about anemia?

7. In what ways can we prevent iron deficiency anemia?
8. What are the symptoms of anemia? How would you identify someone with anemia?

9. If you were worried that your friend was at risk of becoming anemic, what would you tell her to encourage her to change her behaviour?
10. What kind of foods should we eat to get enough iron in our blood?
11. What should we eat in order to benefit from plant sources of iron like alichega, bokoboko, kontomire
12. Name three things you ate yesterday that was an iron rich food.

13. What kind of iron rich foods do you have access to **at home**?
14. What prevents you from eating iron rich foods at home?
15. We've talked about what prevents us from eating iron rich foods at home. How will you overcome this obstacle at home?
16. How will you improve access to iron rich foods at home?
17. Other than educating your parents about what you've learned, how else can you encourage eating foods rich in iron at home?

18. What kind of iron rich foods do you have access to **at school**?
19. What prevents you from eating iron rich foods at school?
20. We've talked about what prevents us from eating iron rich foods at school. How will you overcome this obstacle at school?
21. How will you improve access to iron rich foods at school?

Problem Tree & Consultation

1. Review the elements of the tree – Cause, Effects, Obstacles
2. Put attention of the obstacles
    a. Remind them it is a safe space without judgment
    b. Examples of the obstacles that are most important/relevant in our community
    c. Explain that we want to make videos that will help them teach and influence others
    d. Share examples in their own life of obstacles (if possible, how they overcame it)
    e. To vote – one rock each or anonymous voting (raising hand)
3. Once obstacle is chosen then discuss the details of the solutions.

River of Life

1. Review the purpose of the river of life
2. Remind them of the objective for video two – Topics that should be covered in the River of Life
    a. What is anemia?
    b. What is the cause of iron deficiency anemia?
    c. What are the signs and symptoms of anemia?
    d. What foods should we eat to prevent anemia?
        i. Animal source foods rich in iron

ii. Plant source foods rich in iron.
iii. To help the body absorb plant-based sources of iron, we shoulf also eat foods rich in Vitamin C like oranges, mangoes and tomatoes.

e. Key TO DO message: ***Eat iron rich foods like beans, dark green leafy vegetables or animal foods each day to avoid anemia.***
f. Does the story have a clear obstacle and solution

3. Draw out the story first. (6 scenes)
4. Review - What is a river like. What would prevent the river from flowing? Identify those obstacles in the story.
5. With each scene ask,
    a. "How does the main character feel? If she is _____ what would the river look like?"

Steps to Plan Screening

Watch video

- To show video we would need:
    1. Pico projector with HDMI chord
    2. Speaker(s) with auxiliary chord(s)
    3. White sheet

Informed Consent

- Explain to them what they would be giving consent to. This would be similar to the speech given during assent/consent. Specifically, we would want to highlight that:
    1. Their parents and they have already given consent to them participating in the intervention activities, but that they have the right to change their mind at any time.
    2. Their participation in the filmmaking in voluntary and they had/have a choice to be filmed or not. Their decision doesn't affect their participation in the rest of the intervention activities.
    3. The video will be used for research and educational purposes. We will be screening the video to their friends in the girls club. Next year we will also having open screenings (1 in Asesewa and 1 in their school) where all would be invited to watch. If their video wins the film festival, their video will be screened in 20 schools in UMKD.
    4. We will be taking a video of them saying their name and orally saying that they have watched the video and approve that the video be shared for research and educational purposes. This will be attached at the end of the movie.

Film Consent

- We will be filming all the girls give their oral consent and add it to the end of the movie. This should be very short. The video should include them:
    1. Saying their full names
    2. Introduce the video topic and obstacle they identified.
    3. State that they have consulted, planned and filmed this video. They have watched the final edit and approve that it be used to research and educational purposes.

Plan Screening

- Reflect on purpose of making and screening the video
    1. What do we want the audience to do or think after watching the video?
- Decide what activity or reflection questions we can ask after the video to help the audience reflect on the video's message.
- Plan introduction to the video. What will we say. Who will say it.
- Divide tasks
- Set time & date of screening

Figure A9.3 – Steps used in planning the participatory video screenings

Appendix 10. Consent form for Most Significant Change focus group discussion

This Appendix presents the consent form used towards the Most Significant Change (MSC) focus group discussion

UNIVERSITY OF GHANA

Ethics Committee for Humanities (ECH)

Official Use only
Protocol number

PROTOCOL CONSENT FORM

Section A- BACKGROUND INFORMATION

Title of Study	Evaluating the effectiveness of a participatory video nutrition education trial on nutrition literacy with adolescent girls in the Upper Manya Krobo district, Ghana.
Principal Investigator	Mona Ghadirian, PhD Candidate, McGill University
ClinicalTrials.gov ID	NCT03704649

Section B– CONSENT TO PARTICIPATE IN RESEARCH

General Information about Research

Purpose of the Study: The goal of this research project is to study how different ways of teaching nutrition can influence adolescent girls' nutrition knowledge and diet in Upper Manya Krobo (UMK) district, Ghana. During the 2018-2019 school year, 20 schools in the district will be chosen at random to receive either (i) the usual nutrition education given in the girls' club meetings or (ii) a program where girls' clubs will make short films about nutrition topics, like how to prevent anemia and choose a balanced diet.

The information from this research study may help improve nutrition education for adolescents.

Study Procedures*:* Girls will continue to participate in their regular weekly girls' club meetings that are held at the school and are led by school teachers. If your school is chosen for the participatory video intervention, a number of girls, 12-16 years of age, from the girls' club will benefit from additional film-making activities afterschool like writing a play about healthy eating habits and acting in the play. They will be taught how to use a video camera and make a short 5-7 minute film based on the story they wrote. They may have the opportunity to be in the films the group will produce that will be shown to their fellow club members. They will only be video-taped if they and their guardian had given their approval. Not being video-taped does not affect their participation in the intervention.

The purpose of this focus group discussion is to better understand your experience with the girls' club sessions. We would like to know more about the helpful aspects or challenges you faced in supporting the girls' club activities. Other questions will focus on the changes you may have noticed in the participant's understanding and attitude towards nutrition and changes in their eating behaviour. The focus group discussion will be about 30-45 minutes.

Benefits/Risks of the study

This research aims to increase the understanding of nutrition information and improve the diet of adolescent girls. There are no known risks to your physical, mental or emotional health by being part of the study.

Confidentiality

Each participant will be given a code number to protect the participant's identity. Focus group discussions will be audio-recorded and then translated and written out for our records. Only the researchers and field workers will have access to this information. Audio files of interviews will be deleted after the study is finished and they are only for the use of the researcher. All equipment used in collecting or storing data will be password protected. Hard copies of consent forms, transcripts, and demographic data will be stored in a locked storage cabinet at University of Ghana and McGill University.

You will not be named in any oral or written reports, so that none of the comments you make can be traced back to you. Your identity will be known to other focus group participants and the researchers cannot guarantee that others in these groups will respect the confidentiality of the group. We ask that you respect and maintain the confidentiality of the other participants and not discuss what happened during the focus group outside the meeting.

Compensation There is no payment for participating in this research study.

Voluntary Participation / Withdrawal from Study

Participation in the research activities is voluntary and you can choose to not answer any question or to leave the study at any time. You will not be affected negatively in any way if you choose not to participate.

Contact for Additional Information

If you have questions about the research study, please contact the Principal Investigator, Mona Ghadirian, or any of the co-investigators listed below.

Principal Investigator	**Mona Ghadirian, PhD Candidate** School of Human Nutrition, McGill University CINE Building, Macdonald Campus of McGill University 21 111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, H9X 3V9, Canada Tel: 055 998 9216 or +1 514-835-6884, Email: Mona.Ghadirian@mail.mcgill.ca
Supervisor	**Dr. Grace Marquis, Associate Professor** School of Human Nutrition, McGill University CINE Building, Macdonald Campus of McGill University 21 111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, H9X 3V9, Canada Tel: +1 514-398-7839, Email: Grace.Marquis@mcgill.ca

Collaborators	**Dr. Naa Dodua Dodoo, Lecturer** Regional Institute for Population Studies, University of Ghana, Legon, Ghana Tel: +233 24 457 4434, Email: NDodoo@ug.edu.gh. **Dr. Neil Andersson, Professor** Department of Family Medicine, McGill University 5858 chemin de la Cote-des-Neiges, Montreal, Quebec, H3S 1Z1, Canada Tel: +1 514-398-7375, Email: Neil.Andersson@mcgill.ca

If you have any questions about your rights as a research participant in this study you may contact the Administrator of the Ethics Committee for Humanities, ISSER, University of Ghana at ech@isser.edu.gh / ech@ug.edu.gh or 00233- 303-933-866.

If you have any ethical concerns or complaints about your participation in this study, and want to speak with someone not on the research team, please contact the McGill Ethics Manager at + 1 514-398-6831 or lynda.mcneil@mcgill.ca.

Section C- PARTICIPANT AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and am willing to give consent for me to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

If you consent to participating in the research study which includes participation in a focus group discussion please read and indicate your responses:

Yes:____No:____You consent to being audio-recorded for the focus group discussion.

Name of Participant: (please print) _____

Signature or Thumb-print of Participant:_____Date:_____

If participant cannot read and/or understand the form themselves:
Space is given above if the participant's thumb-print is needed instead of a signature and a witness must sign here.

"I was present while the benefits, risks and procedures were read to the participant. All questions were answered and the volunteer has agreed to take part in the research."

Name of Witness: (please print) _____

Signature of Witness:_____Date:_____

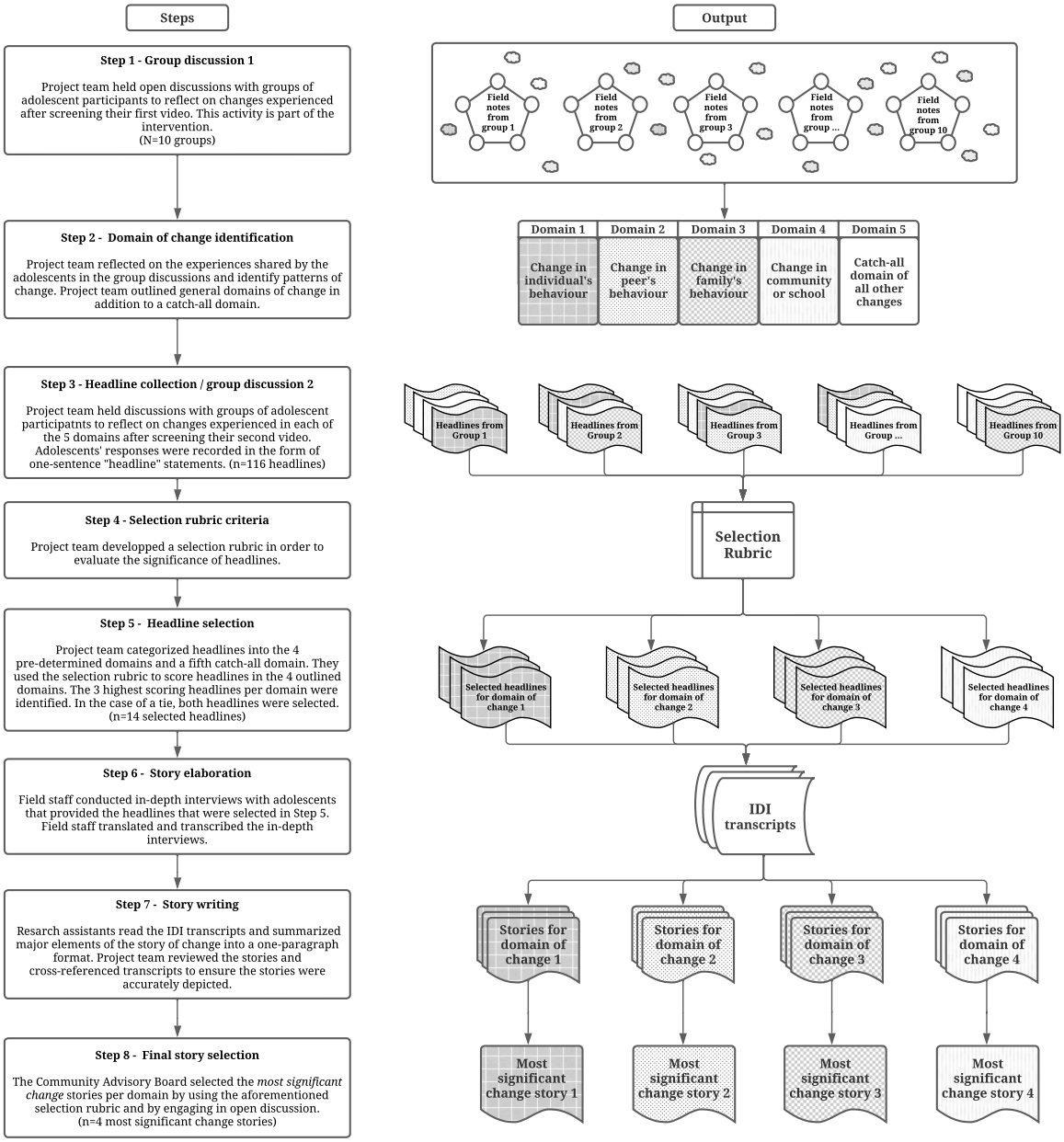
"I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this research have been explained to the above individual."

Name of person who obtained consent: (please print) _____

Signature of person who obtained consent:_____Date:_____

Appendix 11. Most Significant Change method – Outline of steps

This Appendix presents an outline of steps in the Most Significant Change method used in Chapter 5 (Manuscript 3).



Appendix 12. Interview guide for Most Significant Change discussion

This Appendix presents the interview guide used in the in-depth interviews in Chapter 5 (Manuscript 3).

Most Significant Change -
Interview guide for IDI with adolescent girls

Notes:_____
_____
_____

Getting details about the significant change stories

1. You had mentioned an observation about *(refer to their specific significant change story)* during our group reflection. Can you **tell me more** about that story?
    a. *Important to get **details** about:*
        i. What was it like **before the change** occurred? *For example:*
            1. *What did you/your family/your friend eat before the change? Why do you prefer eating those foods?*
            2. *What did your canteen sell before you noticed a change?*
        ii. What were the different **steps** that helped the change occur? (Want a sequence of steps)
            1. *What motivated you to make this change? What do you think started this change?*
            2. *What did you first do to make this change? What did you do next?*
        iii. **Who** was involved?
            1. *Did you get help from anyone?*
            2. *Who did you talk to?*
    b. What (else) **helped** you put the things you learned into practice? What do you think helped bring about this change?
    c. Was there **anything hard** about putting this into practice? If so, what? What helped you get over this challenge?
    d. What does it look like now?
    e. We're trying to figure out what is the most important change story we've seen because of this intervention. **Why do you think this is the most significant change story?**

2. We're trying to figure out how the video/girls' club activities influenced your observation of change. What activities do you think had the biggest influence (positive or negative) on this change? *What helped? What was an obstacle? Can you give me an example?*
3. There are a few different activities we did together like the name game, margolis wheel, problem tree, screening etc. We want to know how a video intervention can better help girls like you with their nutrition needs. If we were to do this intervention again,
    a. What would you change? What would it look like then? Can you give me an example?
    b. What activities do you think we should definitely keep in the intervention?
    c. Describe any challenges or problems you've seen with the participatory video, if any.

4. Do you have anything to add about your experience in the video intervention?

Thank you again for your time.

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Appendix 13. Knowledge mobilization plan

The following are elements of the knowledge mobilization plan that was coordinated with the Community Advisory Board. A special thanks to QES for providing additional funds for these activities.

Asesewa Nutrition Film Festival

Eight of October 2019 in Asesewa, Ghana. Approximately 400 in attendance.

Adolescent girls in the 10 intervention schools made educational videos on prevalent nutritional issues in their respective communities as part of the cluster randomized controlled trial. A total of 20 videos were made on getting a balanced diet and preventing anemia in adolescent girls. These videos were screened to their classmates as part of the intervention. After the research data collection was completed, I consult with the administrators of QES about how we could share these educational videos to community members. One key element of the dissemination plan was hosting a film festival in Asesewa where all 20 of the videos were screened to the public.

The goal of the film festival was to show the videos to a wide range of people who would not only benefit from the key nutrition information in the videos, but also may become ambassadors of its message. We made a concerted effort to invite key stakeholders such as the district Directors of Ghana Education Services and Ghana Health Services, local chiefs and queen mothers, community health workers, and the headmasters and girl child coordinators of the 20 participating schools. Radio announcements were made on market days (2) to invite the wider community to attend. A number of faculty from the University of Ghana were also in

attendance. A number of these stakeholders gave speeches in admiration of the girls' efforts to educate people about healthy eating. They were also given the opportunity to vote on the best video on 1) a balanced diet and 2) anemia in adolescent girls. The winning videos would be screened to community members and parents in each of the 20 schools.

Community video screenings

October 2019 across 20 schools in the Upper Manya Krobo district. Over 400 participants

As part of the intervention activities, intervention groups presented their educational videos on balanced diet and anemia to some of their fellow students. We received positive feedback from these screenings and thought it would beneficial to present these videos to their parents and the wider community.

After the research activities were completed, I coordinate twenty video screenings across the Upper Manya Krobo district as part of a community engagement and knowledge mobilization plan. A screening was held in each of the following 14 communities: Akateng, Dawa Korlewa, Dzomoa, Brepaw Kpeti, Adensu, Akohia, Sawa Yiti, Bisa, Mensah Dawa, Oktrokper, Bormase Hyenya, Konkoney, Fefe, and Sisiamang Yiti and 6 screenings were held at the various participating schools in Asesewa. It is difficult to estimate the average number of participants at these screenings. Some screenings were small with 10-20 participants watching and engaging in discussions about the nutrition topics in the video. Sometimes, over 100 people came to a single screening as all the school children would eagerly sit to watch the videos. Participants included school children, parents, teachers, headmasters and at times, local

traditional leaders such as local chiefs and queen mothers. The audience was presented two videos – one on a balanced diet and the other on anemia in adolescent girls. After the videos were shown, the audience was given ample time to discuss the topics touched in the videos and to ask questions.

In the intervention schools, the girls presented the two videos that they had made to their parents, fellow students, and community members. I was moved by how these parents watched these videos with so much pride. In the control communities, the headmaster and girl child coordinator chose from the top three scoring videos on balanced diet and anemia. These headmasters and girl child coordinators were present at the Asesewa Nutrition Film Festival where they watched all 20 videos and had voted for their favourites. We informed them of the top 3 winning videos per topic and we reminded them of the obstacles the videos talked about. The headmasters and girl child coordinators could then choose the video on balanced diet and anemia that they thought would be most relevant for their population.

A success story

I am very grateful for the opportunity to stay in Ghana for a little longer to plan and execute the Nutrition Film Festival and the 20 local video screenings. There are many examples of success stories that came from these activities. One of my favourite stories is about a father who attended the local video screening in one of our more rural communities. There, he watched his daughter play the role of one of the anemic students in the video. After the video was screened, he shared that his daughter had recently been diagnosed with anemia. He explained how difficult it was for him and his family to understand what had caused this ailment and what they should do to treat

it. He was so proud to see his daughter eloquently explain what anemia was in the video and was grateful to have learned more about it. He asked many questions and frequently expressed his gratitude for the video. This was a reminder of how important iron deficiency anemia is for the girls we were interacting with, how adolescents could be natural teachers in their communities, and how grateful and ready their parents were to learn. Had we not done these local screenings, this vital information might not have reached as many families as we did.