NUT 325: The science base for interventions targeting child malnutrition

Tufts University
Friedman School of Nutrition Science and Policy
FALL 2021

Time and location of the course
Mondays, 1:30-4:30pm, Room J156

Instructors
Shibani Ghosh, Ph.D. | shibani.ghosh@tufts.edu| 617.636.3771 | Skype: shibanighosh1
Office Hours: By appointment on Zoom

Tufts Graduate Credit: 3 credits
Prerequisites for taking this course: Not applicable

Course Description:
This course aims to bring together the current knowledge and evidence in nutrition science and applied nutrition as it translates into policy recommendations and program interventions targeting malnutrition in all its forms in developing countries. It will provide an overview of the global evidence on the status of malnutrition and learn how outcomes such as stunting and wasting became targets of policy and program interventions. The course will do a deep dive and characterize specific nutrient deficiencies or excesses including the epidemiology along with the status of interventions that support eliminating disparities in nutrient access, availability and utilization. Finally, we will review new and emerging considerations within agriculture, nutrition and WASH including the role of the food system, value chains, food safety, infection, environmental enteric dysfunction in supporting nutrition goals set in many low- and middle-income countries. Case studies focusing on current ongoing activities, initiatives and programs will be reviewed and presented.

Course Objectives:
By the end of the course, students will:
1. Learn to analyze current global evidence on the role of diet and non-diet factors in the prevention and treatment of wasting and stunting
2. Link the science around these interventions to programmatic responses on prevention and treatment of wasting and stunting

Description of assignments, tests, and other required activities:
Term paper: The students will be required to select one topic (associated with a class), review and do research on that topic, and develop it into a term paper. The instructor will review the process of selecting a topic during the first session.
In-class presentation: Students will be required to make a 20-minute presentation that corresponds to their term paper topic, using visual tools such as PowerPoint.
Journal club/in-class participation: Students will be assigned a course topic at random for which they will develop discussion questions and lead the class discussion during its designated class period. Class participation during all discussions will also be evaluated.

The following guidelines are used in evaluating course performance:

- Presentations and term papers will be evaluated on the basis of completeness, originality, scientific soundness and relevance to the assigned topic.
- Participation will be evaluated on journal club discussions, presence and active interaction in the discussion of the particular class.

Summary of Assignments and Grading

Assignment(s)	**Grading Weight**
In class presentation	33%
Term paper	33%
Journal club/In-class participation	33%
Total	100%

Penalties for late or incomplete assignments: This will be determined on the discretion of the instructors and based on usually applied practices at the Friedman School.

Course texts and Materials (for the course as a whole)**:** No textbook required. Instructors have specific readings for each class that are listed in the subsequent sections.

Academic Conduct

Academic integrity, including avoiding plagiarism, is critically important. Each student is responsible for being familiar with the standards and policies outlined in the Friedman School's *Policies and Procedures* manual (http://nutrition.tufts.edu/student/documents). It is the responsibility of the student to be aware of, and comply with, these policies and standards. In accordance with Tufts University's policy on academic misconduct, violations of standards of academic conduct will be sanctioned by penalties ranging from grade reduction or failure on an assignment; grade reduction or failure of a course; up to dismissal from the school, depending on the nature and context of any infraction (http://uss.tufts.edu/studentaffairs/judicialaffairs/Academic%20Integrity.pdf).

Course & Assignment Schedule:

This schedule is subject to modifications at the discretion of the instructor.

Date	Session	Topic
Understanding the trends in nutritional epidemiology and systems approach in intervention planning		
9/13/2021	1	Review of syllabus and course timeline Trends in nutritional epidemiology Evidence supporting current recommended interventions
Outcomes of Interest		
9/20/2021	2	Linear growth and growth retardation: origins, measurement and relationship to diet, nutrition and infection
9/27/2021	3	The double burden of malnutrition, origins, measurement and relationship to diet and nutrition
10/4/2021	4	SAM/MAM in complex environments, measuring outcomes and cost-effectiveness
10/11/2021		Indigenous People's Day observed Sign up for Class presentations
Evidence base, controversies, future directions (in children and adult populations)		
10/18/2021	5	Macronutrients: energy, fats and essential fatty acids, protein quality
10/25/2021	6	Zinc, iodine, and multiple micronutrient supplementation
11/1/2021	7	Vitamin A and vitamin D
11/8/2021	8	Iron, folic acid and vitamin B12: Evidence base, controversies, future directions
New and Emerging Considerations		
11/15/2021	9	Infection, inflammation, and its contributors: poor food safety, mycotoxins
11/22/2021	10	Science for effective actions in fragile environments
11/29/2021	11	Infection, inflammation, and its contributors: environmental enteric dysfunction, and the gut microbiome
12/5/2021	12	Class Presentations
12/13/2021	13	Class Presentations
12/20/2021		Term Paper Due

Class 1: Review of syllabus and timeline for course; trends in nutritional epidemiology; interventions and linking evidence to programming

9/13/2021, Monday 1:30-4:30
Instructor: Shibani Ghosh

Learning Objectives: Upon completion of this class, students will:

- Have an overview of course and its objectives
- Understand basic definitions in public health nutrition and epidemiology
- Learn about the interconnectedness of diet, nutrition and infection
- Obtain and overview of the science behind global recommendations and recommended nutrition interventions

Required Readings

1. Victora C.G., Christian P., Vidaletti LP., Gatica-Dominguez G., Menon P., Black RE. Revisiting maternal and child undernutrition in low income and middle income countries: variable progress towards an unfinished agenda. Lancet, March 7, 2021 https://doi.org/10.1016/ S0140-6736(21)00394-9
2. Executive Summary. Global Panel on Agriculture and Food Systems for Nutrition: The cost of malnutrition- why policy action is urgent. Technical brief number 3. July 2016
3. Executive Summary. *Global Nutrition Report 2020: Action on equity to end malnutrition*. Washington, DC.

Additional Readings

4. International Food Policy Research Institute. 2020. *Global Nutrition Report 2020: Action on equity to end malnutrition*. Washington, DC.
5. Bhutta, Z.A., Das, J.K., Rizvi, A., Gaffey, M.F., Walker, N., Horton, S., Webb, P., Lartey, A., Black, R.E., Group, T.L.N.I.R. and Maternal and Child Nutrition Study Group, 2013. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *The Lancet*, *382*(9890), pp.452-477.

Class 2: Linear growth and growth retardation: origins, measurement and relationship to diet and nutrition

9/20/2021, Monday 1:30-4:30
Instructor: Shibani Ghosh

Learning Objectives: Upon completion of this class, students will be able to:

- Understand the origins and definitions of linear growth, stunting and growth retardation
- Learn about growth attainment versus growth velocity
- Assess the relationship of growth and cognitive development
- Understand the long-term consequences of stunting

Journal Club Reading

1. Prentice, A. M., Ward, K. A., Goldberg, G. R., Jarjou, L. M., Moore, S. E., Fulford, A. J., & Prentice, A. (2013). Critical windows for nutritional interventions against stunting. *The American journal of clinical nutrition*, *97*(5), 911–918. https://doi.org/10.3945/ajcn.112.052332
2. Leroy JL, Frongillo E. Perspective: What Does Stunting Really Mean? A Critical Review of the Evidence, *Advances in Nutrition*, Volume 10, Issue 2, March 2019, Pages 196–204, https://doi.org/10.1093/advances/nmy101

Required Readings

1. Hoddinott J., Behrman J.R., Maluccio J.A., Melgar P., Quisumbing A.R., Ramirez-Zea M., Stein A.D., Yount K.M., &Martorell R. (2013). Adult consequences of growth failure in early childhood. The American journal of clinical nutrition,98:1170–8
2. Sudfeld C.R., McCoy D.C., Danaei D., Fink G., Ezzati M., Andrews K.G., & Fawzi W.W. (2015). Linear Growth and Child Development in Low- and Middle-Income Countries: A Meta-Analysis. Pediatrics, 135 (5) e1266-e1275; DOI: 10.1542/peds.2014-3111
3. Vaivada T., Akseer N., Akseer S., Somaskandan A., Stefopulos M., & Bhutta Z.A., (2020). Stunting in childhood: an overview of global burden, trends, determinants, and drivers of decline, The American Journal of Clinical Nutrition, , nqaa159, https://doi.org/10.1093/ajcn/nqaa159
4. DeBoer M.D., Scharf R.J., Leite A.M., Férrer A., Havt A., Pinkerton R., Lima A.A., & Guerrant R.L. (2017). Systemic inflammation, growth factors, and linear growth in the setting of infection and malnutrition. Nutrition, 33, 248-253, https://doi.org/10.1016/j.nut.2016.06.013

Additional Readings

1. de Onis, M., & Branca, F. (2016) Childhood stunting: a global perspective. Maternal & Child Nutrition, 12: 12– 26. doi: 10.1111/mcn.12231.
2. Victora C et al. 2010. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics. 2010 Mar; 125(3):e473-80. doi: 10.1542/peds.2009-1519. Epub 2010 Feb 15.

Class 3: The double burden of malnutrition, origins, measurement and relationship to diet and nutrition

9/27/2021, Monday 1:30-4:30
Instructor: Shibani Ghosh

Learning Objectives: Upon completion of this class, students will:

- Learn about double burden of malnutrition (overweight, stunting)
- Understand the concepts of epigenetic origins of adult disease
- Be able to link malnutrition in early life to adult disease
- The role of poor diets /ultra-processed foods and early life nutrition

Journal Club Reading

1. Spaniol, A.M., da Costa, T.H.M., Bortolini, G.A. *et al.* Breastfeeding reduces ultra-processed foods and sweetened beverages consumption among children under two years old. *BMC Public Health* **20,** 330 (2020). https://doi.org/10.1186/s12889-020-8405-6

Required Readings

1. Adair, L.S., Fall, C.H., Osmond, C., Stein, A.D., Martorell, R., Ramirez-Zea, M., Sachdev, H.S., Dahly, D.L., Bas, I., Norris, S.A. and Micklesfield, L., 2013. Associations of linear growth and relative weight gain during early life with adult health and human capital in countries of low and middle income: findings from five birth cohort studies. *The Lancet*, *382*(9891), pp.525-534.
2. Bove, I., Miranda, T., Campoy, C., Uauy, R. and Napol, M., (201) Stunting, overweight and child development impairment go hand in hand as key problems of early infancy: Uruguayan case. *Early human development*, *88*(9), pp.747-751.
3. Hales C.N. & Barker D.J.P (2001) The thrifty phenotype hypothesis: Type 2 diabetes, *British Medical Bulletin.* 60, 1, 5-20. https://doi.org/10.1093/bmb/60.1.5
4. Pries A.M., Rehman A.M., Filteau S., Sharma N., Upadhyay A., &. Ferguson E.L. (2019). Unhealthy Snack Food and Beverage Consumption Is Associated with Lower Dietary Adequacy and Length-for-Age z-Scores among 12–23-Month-Olds in Kathmandu Valley, Nepal, *The Journal of Nutrition*, 149(10) 1843-1851, https://doi.org/10.1093/jn/nxz140
5. Carolan-Olah, M., Duarte-Gardea, M. and Lechuga, J. (2015), A critical review: early life nutrition and prenatal programming for adult disease. J Clin Nurs, 24: 3716-3729. doi:10.1111/jocn.12951

Additional Readings

1. International Food Policy Research Institute. 2020. *Global Nutrition Report 2020: Action on equity to end malnutrition*. Washington, DC.
2. Uauy R, Kain J. The epidemiological transition: need to incorporate obesity prevention into nutrition programmes. Public Health Nutr. 2002 Feb;5(1A):223-9.

Class 4: SAM/MAM in complex environments, measuring outcomes and cost-effectiveness

10/4/2021, Monday 1:30-4:30
Instructor: Bea Rogers and Ilana Cliffer

Learning Objectives: Upon completion of this class, students will be able to:

- Define etiology of severe acute malnutrition (SAM) and moderate acute malnutrition (MAM) and learn about projects and interventions that target SAM and MAM
- Evidence base around strategies that target MAM
- Learn the concepts of cost-effectiveness and cost-benefit
- Understand the importance of studying cost-effectiveness
- Review evidence of cost-effectiveness linking to the potential for intervention scale up

Journal Club Reading

1. Shen, Y., Cliffer, I.R., Suri, D.J., Langlois, B.K., Vosti, S.A., Webb, P. and Rogers, B.L., (2020). Impact of stakeholder perspectives on cost-effectiveness estimates of four specialized nutritious foods for preventing stunting and wasting in children 6–23 months in Burkina Faso. *Nutrition Journal*, *19*(1), pp.1-18.

Required Readings

1. Cliffer, I.R., Nikiema, L., Langlois, B.K., Zeba, A.N., Shen, Y., Lanou, H.B., Suri, D.J., Garanet, F., Chui, K., Vosti, S. and Walton, S., (2020). Cost-Effectiveness of 4 Specialized Nutritious Foods in the Prevention of Stunting and Wasting in Children Aged 6–23 Months in Burkina Faso: A Geographically Randomized Trial. *Current Developments in Nutrition*, *4*(2), p.nzaa006.
2. Skordis-Worrall, J., Sinha, R., Ojha, A.K., Sarangi, S., Nair, N., Tripathy, P., Sachdev, H.S., Bhattacharyya, S., Gope, R., Rath, S. and Rath, S., (2016). Protocol for the economic evaluation of a community-based intervention to improve growth among children under two in rural India (CARING trial). *BMJ open*, *6*(11), p.e012046.
3. Sadler, K., Bontrager, E., Rogers, B., Coates, J., Ghosh, S. and Kidane, Y., (2012). Food by Prescription: Measuring the impact and cost-effectiveness of prescribed food on recovery from malnutrition and HIV disease progression among HIV+ adult clients in Ethiopia. *Boston: Feinstein International Center, Tufts University*.
4. McEwan, P.J., (2012). Cost-effectiveness analysis of education and health interventions in developing countries. *Journal of Development Effectiveness*, *4*(2), pp.189-213.

Additional Reading

1. Webb, P. (2011). USAID's review of food aid quality. *Food and Nutrition Bulletin* 32 (3) : S131-S133.
2. Rosenberg, I., Tilahun, J., Schlossman, N., Bagriansky, J., Johnson, Q., Webb, P., Rogers, B., & Masterson, A. R. (2011). Nutritional enhancement of US Title II food aid products. *Food and nutrition bulletin*, *32*(3 Suppl), S134–S151. https://doi.org/10.1177/15648265110323S302
3. Suri D. J., Moorthy D., & Rosenberg I.H. (2016). The Role of Dairy in Effectiveness and Cost of Treatment of Children with Moderate Acute Malnutrition: A Narrative Review. *Food and Nutrition Bulletin* 37 (2) 176-185.

Class 5: Macronutrients: Fats and essential fatty acids, protein quality and essential amino acids
10/18/2021, Monday 1:30-4:30
Instructor: Shibani Ghosh

Learning Objectives: Upon completion of this class, students will:

- Outline the basic concepts of energy, macronutrient balance
- Learn about essential fatty acids and their role in affecting nutrition, visual acuity and cognition in early life
- Understand the role of essential and non-essential amino acids in weight gain and linear growth
- Understand the association of protein quality to linear growth

Journal Club Reading

1. Bahwere P., Akomo P., Mwawi M., Murakami H., Banda C., Kathumba S., Banda C., Jere S., Sadler K., and Collins S. Soya, maize, and sorghum–based ready-to-use therapeutic food with amino acid is as efficacious as the standard milk and peanut paste–based formulation for the treatment of severe acute malnutrition in children: a noninferiority individually randomized controlled efficacy clinical trial in Malawi. Am J Clin Nutr 2017;106:1100–12.

Required Readings

1. Middleton, P., Gomersall, J. C., Gould, J. F., Shepherd, E., Olsen, S. F., & Makrides, M. (2018). Omega-3 fatty acid addition during pregnancy. *The Cochrane database of systematic reviews*, *11*(11), CD003402. https://doi.org/10.1002/14651858.CD003402.pub3
2. Ghosh S., Suri D. and Uauy R. Assessment of Protein Adequacy in Developing Countries: Quality Matters. British Journal of Nutrition, 2012
3. Semba RD, Shardell M, Sakr Ashour FA, et al. Child Stunting is Associated with Low Circulating Essential Amino Acids. *EBioMedicine*. 2016;6:246-252. doi:10.1016/j.ebiom.2016.02.030.
4. Kaimila, Y., Divala, O., Agapova, S. E., Stephenson, K. B., Thakwalakwa, C., Trehan, I., Manary, M. J., & Maleta, K. M. (2019). Consumption of Animal-Source Protein is Associated with Improved Height-for-Age *z* Scores in Rural Malawian Children Aged 12–36 Months. *Nutrients*, *11*(2), 480. https://doi.org/10.3390/nu11020480
5. Ghosh, S. A., Strutt, N. R., Otoo, G. E., Suri, D. J., Ankrah, J., Johnson, T., Nsiah, P., Furuta, C., Murakami, H., Perera, G., Chui, K., Bomfeh, K., Amonoo-Kuofi, H., Tano-Debrah, K., & Uauy, R. (2019). A macro- and micronutrient-fortified complementary food supplement reduced acute infection, improved haemoglobin and showed a dose-response effect in improving linear growth: a 12-month cluster randomised trial. *Journal of nutritional science*, *8*, e22. https://doi.org/10.1017/jns.2019.18

Additional Readings

1. van Vught AJAH, Heitmann BL, Nieuwenhuizen AG, Veldhorst MAB, Brummer R-JM, Westerterp-Plantenga MS. Association between dietary protein and change in body composition among children (EYHS). Clinical Nutrition. 2009;28(6):684-8

Class 6: Zinc, iodine and multiple micronutrient supplementation
10/25/2021, Monday 1:30-4:30
Instructor: Shibani Ghosh

Learning Objectives: Upon completion of this class, students will be able to:

- Multiple Micronutrient supplementation in pregnancy and birth outcomes: science and policy interactions
- Role of zinc in diarrhea management and improving growth
- Understand the public health relevance of zinc deficiency and its effects on growth
- Iodine deficiency disorders and their clinical manifestations
- Role of salt iodization in tackling iodine deficiency disorders

Journal Club Reading

1. Smith E.R., Shankar A.H., Wu L.S.F., Aboud S., Adu-Afarwuah S., Ali H., Agustina R., Arifeen S., Ashorn P., Bhutta Z.A., Christian P., Devakumar D., Dewey K.G., Friis H., Gomo E., Gupta P., Kaestel P., Kolsteren P., Lanou H., Maleta K., Mamadoultaibu A., Msamanga G., Osrin D., Persson L.A., Ramakrishnan U., Rivera J.A., Rizvi A., Sachdev H.P.S., Urasaa W., West Jr K.P., Zagre N., Zeng L., Zhu Z., Fawzi W.W and Sudfeld C.R. Modifiers of the effect of maternal multiple micronutrient supplementation on stillbirth, birth outcomes, and infant mortality: a meta-analysis of individual patient data from 17 randomised trials in low-income and middle-income countries. Lancet Global Health 2017; 5:e1090-100.

Required Readings

1. Nestlé Nutrition Institute Workshop Series, Vol. 70. Meeting Micronutrient Requirements for Health and Development. Intervention Strategies to Address Multiple Micronutrient Deficiencies in Pregnancy and Early Childhood. 70th Nestlé Nutrition Institute Workshop, Cebu, March 2011 Editor(s): Bhutta Z.A. (Karachi, Hurrell R.F. (Zurich), Rosenberg I.H. (Boston, Mass.) 2012, pg. 61-73
2. Strand T.A. Chandyo RK., Bahl R., Sharma PR., Adhikari RK., Bhandari N., Ulvik RJ., Molbak K., Bhan MK and Sommerfelt H. Effectiveness and Efficacy of Zinc for the Treatment of Acute Diarrhea in Young Children. Pediatrics Vol. 109 No. 5 May 1, 2002 pp. 898 -903
3. WHO Secretariat on behalf of the participants to the Consultation, M Andersson, B de Benoist, F Delange and J Zupan. Prevention and control of iodine deficiency in pregnant and lactating women and in children less than 2-years-old: conclusions and recommendations of the Technical Consultation. Public Health Nutrition, vol 10, no. 12a, 1606-1611, December 2007

Additional Readings

1. de Benoist B et al. Iodine deficiency in 2007: Global progress since 1993, Food and Nutrition Bulletin, vol 29, no. 3, 195-202, September 2008.
2. Barffour MA, Hinnouho GM, Kounnavong S, et al. Effects of Daily Zinc, Daily Multiple Micronutrient Powder, or Therapeutic Zinc Supplementation for Diarrhea Prevention on Physical Growth, Anemia, and Micronutrient Status in Rural Laotian Children: A Randomized Controlled Trial. *J Pediatr*. 2019;207:80-89.e2. doi:10.1016/j.jpeds.2018.11.022

Class 7: Vitamin A and vitamin D

11/1/2021, Monday 1:30-4:30
Instructor: Shibani Ghosh

Learning Objectives: Upon completion of this class, students will understand:

- Concepts of Vitamin A and Vitamin D deficiency
- Role of Vitamin A in addressing childhood mortality
- Vitamin A supplementation in infants and young children
- Current public health perspective of Vitamin D deficiency

Journal Club Reading

1. Palacios C, Gonzalez L. Is vitamin D deficiency a major global public health problem? *The Journal of steroid biochemistry and molecular biology*. 2014;144PA:138-145. doi:10.1016/j.jsbmb.2013.11.003.

Required Readings

1. Eduardo Villamor and Wafaie W. Fawzi. Vitamin A Supplementation: Implications for Morbidity and Mortality in Children. J Infect Dis. (2000) 182. (Supplement 1): S122-S133.
2. Imdad A, Mayo-Wilson E, Herzer K, Bhutta ZA. Vitamin A supplementation for preventing morbidity and mortality in children from six months to five years of age. Cochrane Database of Systematic Reviews 2017, Issue 3. Art. No.: CD008524. DOI: 10.1002/14651858.CD008524.pub3.
3. Holick M.F. Vitamin D Deficiency. N Engl J Med 2007; 357:266-281July 19, 2007DOI: 10.1056/NEJMra070553
4. Lips P, Cashman KD, Lamberg-Allardt C, et al. Current vitamin D status in European and Middle East countries and strategies to prevent vitamin D deficiency: a position statement of the European Calcified Tissue Society. *Eur J Endocrinol*. 2019;180(4): P23-P54. doi:10.1530/EJE-18-0736

Additional Readings

5. Darlow, B. A., Graham, P. J., & Rojas-Reyes, M. X. (2016). Vitamin A supplementation to prevent mortality and short- and long-term morbidity in very low birth weight infants. *The Cochrane database of systematic reviews*, *2016*(8), CD000501. https://doi.org/10.1002/14651858.CD000501.pub4
6. Tanumihardjo, S. A., Russell, R. M., Stephensen, C. B., Gannon, B. M., Craft, N. E., Haskell, M. J., Lietz, G., Schulze, K., & Raiten, D. J. (2016). Biomarkers of Nutrition for Development (BOND)-Vitamin A Review. *The Journal of nutrition*, *146*(9), 1816S–48S. https://doi.org/10.3945/jn.115.229708
7. Harvey NC, Holroyd C, Ntani G, et al. Vitamin D supplementation in pregnancy: a systematic review. *Health Technol Assess*. 2014;18(45):1-190. doi:10.3310/hta18450
8. K.P. West, J. Katz MSa, S.C. LeClerq BSa, E.K. Pradhan BAa, J.M. Tielsch PhDa, A. Sommer MDa, Prof, R.P. Pokhrel FRCSb, S.K. Khatry FRCSb, S.R. Shrestha MPHb, M.R. Pandey FRCSc. Efficacy of vitamin A in reducing preschool child mortality in Nepal. The Lancet Volume 338, Issue 8759, 13 July 1991, Pages 67-71 (Originally published as Volume 2, Issue 8759)

Class 8: Iron, folic acid and vitamin B12: Evidence base, controversies, future directions
11/8/2021, Monday 1:30-4:30
Instructor: Irwin Rosenberg

Learning Objectives: Upon completion of this class, students will be able to:

- Evidence around iron supplementation and fortification
- Issues around iron supplementation and malaria and impact on anemia levels (Public health)
- Iron/folate supplementation in tandem with intermittent preventive treatment of malaria in pregnant women
- Discuss issues and controversies surrounding folic acid supplementation/fortification
- Understanding the evidence of folic acid supplementation in pregnancy, childhood and pre-conception
- The importance of Vitamin B 12 and effects of its deficiency

Journal Club Reading

1. Sazawal S., Black R.E., Ramsan M., Chwaya H.M., Stoltzfus R., Dutta A., Dhingra U., Kabole I, Deb S., Othman M.K., Kabole F.M. Effect of routine prophylactic supplementation with iron and folic acid on admission to hospital and mortality in preschool children in a high malaria transmission setting: a community-based, randomized, placebo-controlled trial. Lancet, 2006; 367:133-43.

Required Readings

2. Nestlé Nutrition Institute Workshop Series, Vol. 70. Meeting Micronutrient Requirements for Health and Development. Influence of Inflammatory disorders and infection on iron absorption and efficacy of iron-fortified foods. 70th Nestlé Nutrition Institute Workshop, Cebu, March 2011 Editor(s): Bhutta Z.A. (Karachi, Hurrell R.F. (Zurich), Rosenberg I.H. (Boston, Mass.) 2012, pg. 107-116
3. Rosenberg and Selhub. Assessing all the Evidence for Risks and Benefits with Folic Acid Fortification and Supplementation Chapter 24 in Food Fortification in a Globalized World Ed: Mannar and Hurrell.
4. Allen, LH (2009) How common is Vitamin B12 deficiency AJCN 89 (suppl) 693S - 696S
5. Conclusions of a WHO Technical Consultation on folate and vitamin B12 deficiencies. Food and Nutrition Bulletin, vol 29, no. 2 (supplement), S238-S246, June 2008
6. World Health Organization: Guideline: Optimal Serum and Red Blood Cell Folate concentrations in women of reproductive age for prevention of neural tube defects. Executive Summary pages 1-7

Additional Readings

7. Rosenberg IH. A history of the isolation and identification of folic acid (folate). Ann Nutr Metab. 2012;61(3):231-5.

Class 9: Infection, inflammation and its contributors: poor food safety, mycotoxins, environmental enteric dysfunction and the gut microbiome

11/15/2021, Monday 1:30-4:30
Instructor: Shibani Ghosh, Johanna Andrews Trevino

Learning Objectives: Upon completion of this class, students will be able to:

- Understand the interconnectedness of infection, inflammation and nutrition
- Learn the role of poor food safety and food contaminants such as mycotoxins in impairing growth

Journal Club Reading

1. A.J. Sirma, J.F. Lindahl, K. Makita, D. Senerwa, N. Mtimet, E.K. Kang'ethe, D. Grace. The impacts of aflatoxin standards on health and nutrition in sub-Saharan Africa: The case of Kenya, Global Food Security, Volume 18, 2018, Pages 57-61, ISSN 2211-9124 https://doi.org/10.1016/j.gfs.2018.08.001

Required Readings

2. Andrews-Trevino JY., Webb P., Shively G., Kablan A., Baral K., Davis D., Paudel K., Shrestha R., Pokharel A., Acharya S., Wang JS., Xue KS., Ghosh S. Aflatoxin exposure and child nutrition: measuring anthropometric and long-bone growth over time in Nepal, *The American Journal of Clinical Nutrition*, Volume 113, Issue 4, April 2021, Pages 874–883, https://doi.org/10.1093/ajcn/nqaa397
3. Andrews-Trevino JY., Webb P., Shively G., Rogers BL., Baral K., Davis D., Paudel K., Pokharel A., Shrestha R., Wang JS., and **Ghosh S**. Relatively Low Maternal Aflatoxin Exposure Is Associated with Small-for-Gestational-Age but Not with Other Birth Outcomes in a Prospective Birth Cohort Study of Nepalese Infants. Journal of Nutrition. 2019 Oct 1;149(10):1818-1825. doi: 10.1093/jn/nxz122.

Additional Readings

4.

Class 10: Science for effective actions in fragile environments

11/22/2021, Monday 1:30-4:30
Instructor: Patrick Webb

Learning Objectives: Upon completion of this class, students will be able to:

- Understand emerging ideas within the context of nutrition and fragile environments
- How does one prioritize interventions and how does scientific evidence support (or not) the prioritization of interventions

Required Readings

1. Gelb A., and Mukherjee A. Digital technology in social assistance transfers for COVID-19 relief: lessons from selected cases. Center for Global Development Policy Paper 181, September 2020.
2. Global Panel on Agriculture and Food Systems for Nutrition. Strengthening food systems in fragile contexts. Policy brief No 15, August 2020
3. Global Panel on Agriculture and Food Systems for Nutrition. COVID-19: Safeguarding food systems and promoting healthy diets. Policy Brief No. 14. June 2020
4. One Nutrition in Complex Environments: A cluster randomized study in Agago Uganda, supported by USAID Bureau for Resilience and Food Security, Proposal.
5. Gupte J and Longhurst R. 2019. How do the state's organizational capacities at the micro- and macro-levels influence agriculture-nutrition linkages in fragile contexts? *Food Policy*, 82: 74-83, https://doi.org/10.1016/j.foodpol.2018.10.016
6. Taylor S, et al. 2015. Scaling up nutrition in fragile and conflict-affected states: The pivotal role of governance, *Social Science & Medicine*, 126: 119-127, https://doi.org/10.1016/j.socscimed.2014.12.016

Additional Readings

Class 11: Infection, inflammation and its contributors: environmental enteric dysfunction and the gut microbiome
11/29/2021, Monday 1:30-4:30

Instructor: Shibani Ghosh

Learning Objectives: Upon completion of this class, students will be able to:

- Understand the interconnectedness of infection, inflammation and nutrition
- Learn about environmental enteric dysfunction and the gut microbiome

Journal Club Reading

1. Owino, V., Ahmed, T., Freemark, M., Kelly, P., Loy, A., Manary, M. and Loechl, C., 2016. Environmental enteric dysfunction and growth failure/stunting in global child health. Pediatrics, 138(6), p.e20160641.

Required Readings

1. Lauer JM., **Ghosh S.,** Ausman LM., Webb P., Bashaasha B., Agaba E., Turyashemererwa FM., Tran HQ., Gewirtz AT., Erhardt J., Duggan C. Markers of environmental enteric dysfunction are associated with poor growth and iron status in rural Ugandan infants. J Nutr. 2020; https://doi.org/10.1093/jn/nxaa141
2. Lauer J., Duggan C., Ausman L., Griffiths J.K., Webb P., Bashaasha B., Turyashemererwa F.M., **Ghosh S**. Unsafe drinking water is associated with environmental enteric dysfunction and poor growth outcomes in young children in rural southwestern Uganda. Source: The American Journal of Tropical Medicine and Hygiene, Volume 99, Issue 6, 5 Dec 2018, p. 1606 – 1612 DOI: https://doi.org/10.4269/ajtmh.18-0143

Additional Readings

3. Crane, R.J., Jones, K.D. and Berkley, J.A., 2015. Environmental enteric dysfunction: an overview. Food and nutrition bulletin, 36(1_suppl1), pp.S76-S87.
4. Trehan, I., Kelly, P., Shaikh, N. and Manary, M.J., 2016. New insights into environmental enteric dysfunction. Archives of disease in childhood, pp.archdischild-2015.
5. Agapova SE, Stephenson KB, Divala O, et al. Additional Common Bean in the Diet of Malawian Children Does Not Affect Linear Growth but Reduces Intestinal Permeability. *J Nutr*. 2018;148(2):267-274. doi:10.1093/jn/nxx013
6. Gehrig JL, Venkatesh S, Chang HW, et al. Effects of microbiota-directed foods in gnotobiotic animals and undernourished children. *Science*. 2019;365(6449):eaau4732. doi:10.1126/science.aau4732
7.

Class 12: Class Presentations
12/06/2021, Monday 1:30-4:30

Class 13: Class Presentations
12/13/2021, Monday 1:30-4:30