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COMMENTARY

Adolescent education: an opportunity to create a Developmental Origins of Health and Disease (DOHaD) circuit breaker

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Health before conception, and periconceptional nutritional environments, contribute to conditioning of later-life health and disease. Health behaviors developed during adolescence continue into adulthood. Thus, even when the gap between pregnancy and adolescence is substantial, behaviors developed during adolescence influence later-life non-communicable disease (NCD) vulnerability in offspring. Consequently, adolescence is an important life phase where development of positive health behaviors can contribute to disruption of transgenerational cycles of NCD risk. Schooling is a core activity during adolescence. Modern curricula focus on development of capabilities associated with critical, engaged citizenship, empowering learning that supports action-based engagement in complex issues. Contexts relevant to adolescents and their communities, such as the NCD epidemic, are used to facilitate learning. Thus, engaging the education sector as participants in the work of the Developmental Origins of Health and Disease community offers an important strategy to capture the potential of adolescence as a life stage for transgenerational primary prevention of obesity and NCD risk.

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Adolescence: a life stage for translation of Developmental Origins of Health and Disease (DOHaD) evidence into action

The field of DOHaD has provided epidemiological and experimental evidence indicating that nutritional and non-nutritional exposures, during preconception and developmental periods, contribute toward later-life vulnerability to obesity and chronic diseases such as type 2 diabetes mellitus and coronary heart disease.[1] This evidence has been successfully communicated to the science and health research sectors, now reaching a point where population-wide application is being promoted by organizations of global significance.[2] This heralds a growth phase for the DOHaD Society, requiring increased breadth of scope and capabilities to enable knowledge exchange with governmental and community organizations that have the potential to facilitate population-level application of DOHaD evidence.

To date, attention on DOHaD intervention opportunities has largely focused on mothers and children. However, application of DOHaD evidence in conjunction with evidence surrounding adolescent development (cognitive and psychosocial) points strongly toward the validity of adolescence as a DOHaD intervention stage.[3] In presenting this argument, it is important to appreciate that behavior patterns exhibited during adolescence, including those associated with diet, physical activity and cognitive development, track through to adulthood,[4,5] and are associated with future health.[3] Thus, even when adolescence is significantly distanced from pregnancy, capabilities and behaviors that evolve during this period will influence preconception and periconceptional health and environmental exposures, thus contributing to the prospect of improved long-term health potential for offspring.

Schooling is a core social structure providing in-depth engagement with adolescents up to the age of 11–18 years (variably by context). Within this often *relatively* well-resourced social structure exists opportunities for empowerment-based learning interventions supporting adolescents to engage with, understand, contextually interpret, and act upon life course non-communicable disease (NCD) risk evidence. Such interventions must not be additional to the core business of the school. They should be integrated into existing curriculum, assessment and pastoral care objectives, and have relevance to the socioecological context of the school community.

Intervention design, facilitation and evaluation requires understanding of education, DOHaD and public health, alongside professional capabilities associated with the design, delivery and assessment of adolescent education. Therefore, this activity requires collaboration between education, science and health. Collaborations must enable teachers and education leaders to examine relevant evidence and determine where and

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how DOHaD-informed interventions may exist so as to support the objective of positive adolescent health behavior development, while simultaneously contributing toward core educational objectives of schools. Thus, if the work of the DOHaD Society is to include interventions that 'promote healthy early development, beginning even before conception, as well as interventions aimed at sustaining health in children, adolescents and adults,'[6] it is important that expertise from the education sector is incorporated into the Society to support child and adolescent aspects of this work.

A growing number of DOHaD translation programs addressing the potential of school-based education to empower action competence leading to behavior change in adolescents have been developed, and in some cases, evaluated and shown to have potential for population-level integration.[7–10] As primary to secondary (K-12) education is not the core work of most within the DOHaD Society, we believe that this short commentary outlining how the education sector can engage with DOHaD communities to develop and facilitate interventions may be of assistance to scientists interested in exploring the potential of collaboration with education to '… promote the health of the current generation … [and] … ensure a healthy life course for future children and grandchildren.'[6]

Schooling: where and how could DOHaD-informed community partnership actions fit?

Capturing the potential of school-based DOHaD interventions requires the development of partnerships between DOHaD research and education communities. Such partnerships should be jointly informed by scientific evidence and understanding of the nature of pedagogy, curriculum and practice in modern schooling. When presenting evidence of impact of the Liggins Institute's *Healthy Start to Life Education for Adolescents Project*,[7] we are frequently asked by scientists how we 'got DOHaD into the school curriculum?' The answer is, we did not. Modern curricula[a] almost universally specify the development of capabilities, but do not specify the context in which this may occur. Therefore, we identified where and how it would be appropriate to integrate DOHaD and life course NCD risk as contexts of relevance to adolescents, through which teachers may develop and facilitate learning programs supportive of curricula goals and the learning needs of students.[11]

The focus of education has moved considerably in the past 20 years. No longer is education primarily concerned with the mastery of content knowledge. Rather, in response to the rapid pace of societal development, modern education systems are designed to prepare young people to participate as critically engaged citizens and life-long learners able to negotiate present realities as well as futures that we cannot predict. Curricula focus on the development of capabilities (knowledge, understanding, skills, attitudes and values) that enable critical and active participation in all aspects of society. Often referred to as 21st century skills and dispositions these capabilities cultivate 'critical and creative thinking, collaborative skills and dispositions, leadership, entrepreneurship, and related skills and dispositions that speak strongly to living and thriving in our era.'[12]

While in the past knowledge acquisition was commonly dissociated from context within schooling, learning in modern education systems is contextual. This enables young people to develop, refine and apply capabilities within contexts of local and global relevance, and is supportive of the development of action competencies, a precursor to evidence-based decision making.[13] Learning areas (disciplines) that lend themselves to the use of DOHaD as a context of relevance include sciences, health, social sciences, languages, technology and physical education. Although this may seem diverse, and science and health will take a leading role, the diversity reflects the breadth of capabilities required for critical citizenship and the importance of interdisciplinary learning to enable adolescents to develop competencies relevant to diverse and complex issues that require application of systems thinking.[14] For example, in the Cook Islands the national college is utilizing DOHaD/NCDs as a cross-disciplinary learning context in science, social science, health and physical education at Year 9, whereas in Year 11 it is being used solely in science. A neighboring school is utilizing the context in an integrated program crossing science and languages at Year 11, whereas at Year 9 they are currently only using the context in science while they build appropriate staff capacity to enable inclusion of the context in cross-disciplinary learning. These examples reflects the breadth of opportunity for learning that teachers identify in DOHaD/NCD contexts. They also reveal the importance of context and the centrality of school-level autonomy in education. Although these schools are part of a cluster developing the use of DOHaD/NCD contexts to support national education and health strategy, their programs are differentiated in accordance with contextual variance in each school community.

Learning programs should always be flexible so that teachers can adapt objectives and resources to meet individual and collective learning needs of the students in their classroom. Educators share and use programs that provide adaptable resources enabling teachers to develop appropriately differentiated programs. Using approaches such as the action research informed 'teaching as inquiry cycle,'[15] teachers continuously analyze student engagement and performance, and accordingly adjust program design to inform ongoing learning within the current cohort, and program design for future cohorts. Thus, school learning environments and the programs within them are dynamic. DOHaD-informed school-based interventions need to be designed to empower teachers to

[a] The term curriculum in education refers to a policy document created nationally and adapted locally to define high-level objectives that guide learning and teaching in schools. From these documents, teachers create annual work plans, composed of learning modules/units/programs that collectively support the objectives of the curriculum. We make this point because the term curriculum is often used differently in science and health sectors where it can describe a discrete series of lessons, which in the education sector would be called a learning program or module. This sectoral difference in the use of terminology can cause considerable confusion if it is not understood.

analyze and adjust programs, ideally in professional clusters within or between schools that are connected to a DOHaD community and the local health community, and therefore offer both educational and DOHaD engagement in the process of analysis and contextual refinement.

Health literacy: a component of the capabilities required to engage in and act upon DOHaD evidence

The promotion of health literacy development in adolescence is identified as an aim by the DOHaD Society.[6] However, to achieve transformative empowerment enabling adolescents as decision makers, health literacy development must be seen as a component within a matrix of interrelated capabilities that enable application of knowledge, understanding and critical thinking skills to support evidence-based actions supportive of life course and intergenerational health and well-being. These capabilities include the following: health, scientific and environmental literacies; knowledge of and about the impact of social, cultural and economic and political factors on well-being (individual and societal); and metacognitive and critical thinking (identified as central to transformative learning[16] and integral to competencies required for citizenship). Therefore, development leading to empowerment is a complex educational task requiring considerable time. The potential for and nature of transformative action emerging from interventions supporting empowerment will be determined by interactions between capability development, access to evidence, opportunities for discourse and the socioecological context of the individual and community. Although challenging, this task fits extremely well with the development of 21st century capabilities promoted in the education sector. Therefore, it is important not to approach adolescent interventions with a narrow focus on health, but rather to ensure that teachers across the spectrum of relevant learning areas are provided with the opportunity to engage with DOHaD evidence and its application as a context of educational relevance.

Intermediaries: enablers working between DOHaD and education communities

Although scientists should be involved in aspects of the intervention partnership, it is an unusual scientist who has capabilities and expertise in communication and learning required to facilitate adolescent education interactions of the nature we have described. Therefore, connections are required between DOHaD and in the case of school-based adolescent interventions, education communities. These can be facilitated by intermediaries, 'people with the knowledge, experience and dispositions that enable them to effectively liaise between the education and science communities.'[17] Although Bolsted *et al.*[17] focus on the need for intermediaries to have 'a sophisticated level of understanding of the multiple purposes of science learning, and familiarity with the operational characteristics of school science teaching and learning, including curriculum and assessment frameworks, and whose work often involves building and maintaining relationships, seeking and managing funding and resourcing, and identifying areas where research or evaluation is needed to contribute to the development or refinement of programs', we suggest that intermediaries also need to develop in-depth understanding of DOHaD science and public health.

Significant roles for intermediaries enabling school–DOHaD partnerships include building engagement and relationships between DOHaD and education communities that facilitate awareness of intervention potential; re-imaging of research data for use in adaptable learning resources;[11] facilitation of professional learning and development communities and related resources[18] that empower teachers to engage in and develop the use of DOHaD research as contexts for learning; and research evaluating intervention impact and informing development.

The process of data re-imaging is collaborative, requiring scientists and educators to examine how data can be presented in meaningful formats for students of different ages. We have found that for K-12 education settings, presenting data within narratives about scientists and the process of science, accompanied by narratives that participating communities provide about their experiences of NCDs,[19] is an enabler of interaction in classrooms. In addition, via these stories, young people can take DOHaD evidence into their homes and facilitate evidence-based behavior change at the family level.[7]

In addition to resources, transactional engagement is required between stakeholders from communities who have developed or fully understand the evidence, and teachers in communities for whom the evidence may have application. This engagement should enable exchange of ideas, issues and evidence, leading to synthesis of the relevance and potential of DOHaD evidence within the particular context. Transformative learning theory examines the processes of critical reflection that leads learners to examine, assess and potentially alter their frame of reference with regard to a particular issue.[16] It is known to lead to active decision making and action taking. Although the objective of interventions is to achieve this goal for students, transformative learning is also required to support teachers to identify with the value of the DOHaD context, and to engage personally with the evidence. Transformative learning is often stimulated by a disorienting dilemma. In the case of DOHaD-informed interventions this may be engagement that leads participants to examine, for example, the extent to which obesity is impacting people/communities/societies. Via critical assessment and examination of assumptions, frames of reference are exposed and can be challenged. When learners are exposed to alternative frames of reference, via critical analysis they are able to evaluate and potentially alter their view point. This leads to exploration of options, identification of alternative actions, active experimentation and eventually new frames of reference, which in the case of understanding of the role of early life exposures in vulnerability to NCD risk, could lead to behavior change. Teachers need to experience this process of critical reflection with regard to frames of reference related to NCD risk before they can facilitate educational

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programs that will enable adolescents to examine and make meaning of DOHaD evidence. Therefore, creating opportunity for learning such as this is a key purpose of professional learning communities that engage DOHaD and education together.

Conclusions

To unlock the potential of DOHaD evidence to improve health and social well-being requires society to be given the opportunity to learn about this evidence, examine its relevance and make decisions about how it is used, thus facilitating community-led actions. This requires knowledge exchange between the DOHaD community, and all communities where families desire their children to grow and contribute as healthy adults within society. Health and education professionals in regular contact with families and young people during developmental periods from pre-conception through childhood and adolescence are in the best position to implement programs supporting and empowering families to engage in health-promoting behaviors.[20,21] These sectors have expertise in communication, learning, community engagement and behavior required to support sustained interactive intervention programs within existing social settings. However, they also require opportunities to develop understanding of relevant scientific evidence. For the education sector, NCD risk reduction is not core business, therefore it is important to create opportunities to engage this sector and identify shared value that can emerge from their participation in DOHaD-informed adolescent interventions. The DOHaD Society has confirmed the potential of adolescent interventions in the Cape Town Manifesto. Achieving positive action with regard to the goals relevant to adolescent education could be significantly enhanced by increased educational input into the work of the Society and consideration of strategies that may enhance the availability of DOHaD relevant resources to the education sector.

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Conflicts of Interest

None.

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