

REVIEW

Towards an equity competency model for sustainable food systems education programs

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Addressing social inequities has been recognized as foundational to transforming food systems. Activists and scholars have critiqued food movements as lacking an orientation towards addressing issues of social justice. To address issues of inequity, sustainable food systems education (SFSE) programs will have to increase students' equity-related capabilities. Our first objective in this paper is to determine the extent to which SFSE programs in the USA and Canada address equity. We identified 108 programs and reviewed their public facing documents for an explicit focus on equity. We found that roughly 80% of universities with SFSE programs do not provide evidence that they explicitly include equity in their curricula. Our second objective is to propose an equity competency model based on literature from multiple fields and perspectives. This entails dimensions related to knowledge of self; knowledge of others and one's interactions with them; knowledge of systems of oppression and inequities; and the drive to embrace and create strategies and tactics for dismantling racism and other forms of inequity. Integrating our equity competency model into SFSE curricula can support the development of future professionals capable of dismantling inequity in the food system. We understand that to integrate an equity competency in our curricula will require commitment to build will and skill not only of our students, but our faculty, and entire university communities.

Keywords: Sustainable food systems education; Equity; Competency model; Pedagogy

Introduction

Sustainable Food Systems Education (SFSE) programs are degree programs, specializations, and certificates with a common goal to support post-secondary students across a range of disciplines in developing the knowledge, skills, and dispositions to support socially just, economically

viable, and ecologically regenerative food systems (Valley et al., 2018). Consider three scenarios that describe situations that a graduate of a SFSE program might face upon entering the workforce.

Scenario 1: In Vancouver, a community-based organization serves thousands of meals each day in a mixed-race neighborhood where many households face persistent challenges in meeting basic food and housing needs. Clients line up for meals. Some of the white men in line noticed that elderly Chinese women were getting food, packing it up in take-away containers, and then going home, changing clothes, and re-entering the line to get more food. The men were angry and threatened violence over what appeared to them as 'double-dipping', asserting that the Chinese women were taking the food and re-selling it in their shops (Huang et al., 2014). What should be done about this problem? How can food systems students, who might face this kind of situation as organizers or as representatives of clients in line, for instance, be prepared to address issues of this nature?

Scenario 2: Members of the Inter-institutional Network for Food, Agriculture and Sustainability (INFAS) noted that a report on land-grant universities, to which many of the group had contributed, omitted the impact of race on equity (INFAS, 2015). What should be done about this omission? How can food systems students be prepared to

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understand and contribute to reports of this nature with full awareness of the effects of race on access to institutional services? What kinds of changes would need to be in place in food systems practitioner training, related curricula and practicum-based learning?

Scenario 3: In the United States between 2017 and 2018, during the build-up to a new Farm Bill, attention focused on the Supplemental Nutrition Assistance Program (SNAP), specifically on whether or not recipients' food choices should be restricted, and whether or not recipients should have stricter work requirements to merit participation. Yet the discussion very seldom shifted to *why* so many people in the U.S. require food assistance, and how to raise wages and access to decent jobs to allow every household to enjoy healthy, sustainably produced, and culturally relevant food in a dignified manner. What should be done about this gap in discourse? How can food systems students and professionals be prepared to address root causes of food system issues, rather than just treating the symptoms?

These three scenarios illustrate challenges encountered by current professionals working to transform food systems toward sustainability. A prominent theme that ties these scenarios together is the concept of equity. Equity is defined by Braveman and Gruskin (2003, p. 254) as “the absence of systematic disparities ... between groups with different levels of underlying social advantage/disadvantage—that is, wealth, power, or prestige.” Viewed through the lens of equity, processes resulting in social inequality are understood to need intervention largely at systems or institutional level, rather than solely at the individual level (Allen, 2010). Therefore, a focus on equity, often described as food justice, centers explicit calls for addressing issues of systemic and structural inequities as part of food system transformation (Alkon and Agyeman, 2011; Ammons, 2018; Alston, 2017; Cohen and Gregory, 2009; NSAC, 2016; INFAS, 2015; Holt-Giménez, 2016; Farrell, 2017; TEEB, 2018; UNESCO, 2002).

Food systems-related inequities have been documented through scholarly publications that highlight relationships with race (Sbicca and Myers, 2017); income and food insecurity (Loopstra and Tarasuk, 2013); gender relations and power (Allen and Sachs, 2012; Shisler and Sbicca, 2019); sexual orientation (Sbicca, 2012; Leslie et al., 2019); and decolonization and Indigenous food sovereignty (Morrison, 2011; Whyte, 2016; Daigle, 2019). The initial impacts of COVID-19 pandemic are unveiling a range of racial and economic injustices, as historical evidence shows is often the case for populations and communities on the margins experiencing higher prevalence of social inequalities (Wade, 2020). This includes injustices related to the food system, such as reliance on migrant and undocumented farmworkers (Hayley et al., 2020); unsafe labour standards in the field and in meat packing plants (Dyal, 2020; CDCP, n.d.); high-risk working conditions and low pay of food retail workers (van Dorn et al., 2020); and increased use of emergency food systems as unemployment numbers reach record levels, incomes drop and federal food assistance programs have insufficient funds to adjust (Dunn et al., 2020). However, it is unclear how, and

to what extent, SFSE programs are preparing graduates to recognize and address issues of equity.

In this paper, we explore the critical need to integrate equity – emphasizing racial equity and its intersectional ties with other inequities – into SFSE programs by focusing on the articulation of an equity competency. The purpose of this paper is to contribute to the scholarship of teaching and learning in higher education programs whose graduates will be involved in, and have responsibilities for, the development of healthy, just, and sustainable food systems. Our goal is to support individuals involved in the design, implementation, and evaluation of SFSE programs to explicitly embed equity into their curriculum. The first objective of this paper is to examine the state of equity-related discourse evident in current SFSE programs in the United States and Canada through the analysis of public-facing information, such as websites with program and course descriptions. The primary research questions associated with this objective are, to what extent do existing SFSE programs publicly state their explicit integration of equity? And if equity-related elements exist, what form of equity is addressed?

Our second objective is to propose an equity competency model for SFSE programs that integrates concepts from Education for Sustainable Development (ESD) and SFSE scholarship in addition to the literature on domain-general competencies from the Association of American Colleges and Universities (AACU, 2014a, b) and diversity education; multicultural, diversity, and social justice competencies articulated in the fields of counseling, social work, planning, and nursing; guidelines developed by the Center for Social Inclusion, a non-profit organization working towards dismantling racial inequity in the food system; and the authors' own experience in trying to teach equity. The competency model can be used to build, assess and communicate specific knowledge, skills, and attitudes at the program and course levels.

The authors of this paper are members of a Community of Practice (CoP) on Food Systems Pedagogy based in the Institute of Human Nutrition at Columbia University. Initiated in 2016, this CoP convenes academics and practitioners focused on food systems education to share knowledge, create space for exchange, and problem-solve. During a 2017 workshop, which brought over 150 representatives from 26 colleges and universities in the U.S. and Canada, CoP members discussed competencies that food systems professionals need. A competency is “a functionally linked complex of knowledge, skills, and attitudes that enable successful task performance and problem solving” (Wiek et al., 2011, p. 204). A focus on competency development in SFSE programs orients instructors and students toward cultivating learning experiences across a degree program that will prepare graduates for professional responsibilities, roles, and capabilities to address complex problems and contribute to dismantling of structural inequities in food systems. The authors have continued convening to discuss SFSE competencies since the 2017 CoP gathering, and the cross-cutting importance of equity emerged through these dialogues.

We begin by reviewing recent calls for addressing issues of equity in food justice and food systems education literature. We describe the value and nature of competency articulation for learner-centered programs in higher education and the current state of competency frameworks related to ESD and SFSE programs. We then review the connections between the ESD and SFSE literature and equity-related competencies.

A focus on equity, food justice and sustainable food systems education

Efforts to transform food systems have been critiqued by activists and scholars as lacking a distinct orientation towards addressing issues of social justice (Allen, 2008; Guthman, 2008; Alkon and Agyeman, 2011). Food system sustainability projects may reinforce social inequities by assuming everyone has equality of opportunity to access healthy food based on their merits and rights alone, or by assuming that increasing the global (or local) number of organic farms will result in a more equitable distribution of health promoting food across a population. As Sensoy and DiAngelo (2017) note, inequality exists and is deeply ingrained into society in ways that ensure its reproduction. Categories of difference (e.g., race, class, gender, ability level, sexuality) are important contributors to inequity, as opposed to merit alone. Thus, aims to dissolve differences under assumptions of pre-existing equality of opportunity, or merit, have resulted in such notions as colour-blindness (not 'seeing' race), universalism (Guthman, 2008), and assumptions of similarity (Allen, 2008). In contrast, a focus on equity means that food system transformation has an explicit orientation towards "acknowledging and confronting historical, collective social trauma and persistent race, gender, and class inequalities" (Cadieux and Slocum, 2015, p. 13).

Critiques of food system sustainability projects have resulted in government and non-profit organizations employing food justice as part of their discursive framing of transformative food practices (Cadieux and Slocum, 2015). As defined by Gottlieb and Joshi (2010, p. 223), food justice seeks "to achieve equity and fairness in relation to food system impacts and a different, more just, and sustainable way for food to be grown, produced, made accessible, and eaten." Gibb and Wittman (2013), drawing upon environmental justice literature, articulate three dimensions of food justice: distributive, procedural, and epistemic. Their distinctions broaden the recognition of justice from the distribution of material goods to questions of representation and power in decision-making processes (procedural), and whose knowledge (epistemic) is privileged, absent, dismissed, or disappeared.

In the United States and Canada, food systems are built on a history of racial inequity and settler colonial violence. Racism is a critical social inequity to address, given race's historic, persistent, and pervasive impact and its intersection with exploitative forms of globalization (Holt-Giménez, 2016). As stated by McAfee et al. (2015, p. 3):

"Race remains the fundamental fissure in America; it compounds and perpetuates disadvantage across

neighborhoods and generations.... Racial inequities persist in all sorts of policies and practices, implicitly and explicitly.... In fact, racial disparities exist on every measure of individual and community well-being."

Michigan State University's report, "Measuring racial equity in the food system: established and suggested metrics", acknowledges the multiple arenas in which racial inequity persists in the food system (Rodman-Alvarez and Colasanti, 2019). Whiteness is hegemonic, and without explicit attention to race and racializing processes, alternatives are likely to reproduce racial inequities (Slocum, 2007). Cadieux and Slocum (2015) call for increased clarity and accountability in food justice practice in order to avoid furthering white privilege in the food system. They also emphasize the historical role of anti-racism work as foundational to food justice, while acknowledging that there are multiple and intersecting forms of food system disparity by (but not limited to) class, gender, sexual orientation, and ability level. Addressing the many structural inequities moves us towards a society in which all individuals have the opportunity to fully participate in, and enjoy the benefits of, food systems (Smith, 2019; Ammons et al., 2018).

Food systems education has been critiqued for its inadequacy in creating educational conditions for learners to gain knowledge of racialized inequities in contemporary food systems, limiting student capacity to do food justice work (Meek and Tarlau, 2015). Food systems programs that use vague and general terms that lack explicit distinctions of the nature or direction of an inequity or power differential and that could be applied to a variety of dominant or oppressed social groups may be initiating educational functions that are insufficient for transformational change. Anderson and colleagues (2019, p. 525) emphasize the need for curriculum in SFSE-related programs to shift towards explicitly identifying "how interlocking systems of power impact those who are most marginalized in society." The Sustainable Agriculture Education Association (SAEA), an educational non-profit society focused on the development and exchange of teaching and learning practices in higher education, published an equity statement¹ that "acknowledges and endorses teaching and learning as a vital means to overcoming systems of oppression" (SAEA, 2019).

Calls for addressing inequities will require a willingness by both educators and students to identify challenges, but also to develop the skills and dispositions to engage with community members and political entities to develop and integrate sustainable, place-based, justice-oriented solutions. Increasingly, complex educational outcomes of this nature, which bundle knowledge, skills, and attitudes, are being articulated as competencies.

Competencies, education for sustainable development, and sustainable food systems education

Competency frameworks are becoming common as higher education moves away from a transmissive model of the transfer of knowledge from expert to novice, and

increasingly emphasizes the need for learner-centered, skill-oriented curricula and program learning outcomes (Wiek et al., 2011; Wilhelm et al., 2019). Proponents of this shift assert that competencies are meaningful reference points for articulating and measuring student learning and teaching effectiveness, as well as increasing transparency and accountability in the learning process (Lozano et al., 2017; Wiek et al., 2015). Wilhelm and colleagues (2019) state that it is important to acknowledge that one cannot teach competencies, they can only be acquired in a specific context. Further, students express a competency through performance, applying their knowledge and skills to address a specific issue. In order to address issues of equity in the food system, SFSE programs will need to increase students' knowledge and understanding, and create opportunities to practice doing food justice.

Competencies have been developed and widely debated within education for sustainable development (ESD) (Engle et al., 2017; Lozano et al., 2017; Wiek et al., 2011; Wiek et al., 2015). Lozano and colleagues (2017) reviewed the ESD literature and created a synthesis of twelve competencies: systems thinking; interdisciplinary work; anticipatory thinking; justice, responsibility, and ethics; critical thinking and analysis; interpersonal relations and collaboration; empathy and change of perspective; communication and use of media; strategic action; personal involvement; assessment and evaluation; and tolerance for ambiguity and uncertainty. In the growing literature on SFSE, many authors have put forth ideas of what concepts, skills, or values they believe students and professionals ought to learn, know and/or practice; however, competencies and competency models are much less prevalent. Galt, Parr, and Jagannath (2013) suggested a competency model that included seven realms (ways of knowing and learning, understanding values, the inquiry process, analysis, interpersonal skills, writing, and presenting) and corresponding learning objectives for an introductory undergraduate food systems course. Anderson (2013) built on ESD competencies for SFSE, adding historical analysis, and extending interpersonal competency to encompass intercultural and inter-institutional domains, the ability to synthesize knowledge from multiple sources, and development of personal values congruent with sustainability. Others have proposed a model of competencies for agroecological education that includes observation, participation, dialogue, reflection, and visioning (Francis et al., 2018; Migliorini and Lieblein, 2016). Valley and colleagues (2018) outlined a structure to a competency model in their signature pedagogy framework, identifying specific domains of "knowledge and know-how" and "values and dispositions" for SFSE. Ingram and colleagues (2020) identify learning outcomes of the Interdisciplinary Food Systems Teaching and Learning (IFSTAL) program, which integrates knowledge, skills, and attitudes related to developing capacities for food systems thinking, necessary for addressing complex food system challenges.

Within the ESD and SFSE literatures, multiple competencies are related to equity, but few if any explicitly call for the development of an equity competency. Authors have identified normative, ethical, or understanding values competencies (Engle et al., 2017; Galt et al., 2013;

Lozano et al., 2017; Wiek et al., 2011). These competencies generally focus on identifying, understanding, and in some cases negotiating values between stakeholders as well as applying concepts related to justice and equity. A notable exception is Habron (2012), whose model of eleven sustainability competencies for a sustainability minor at Michigan State University explicitly identifies and integrates issues of equity into learning outcomes. For example, students are required to demonstrate knowledge of how individuals and social groups experience inequality, articulate historical and current social justice issues, and describe their relevance to sustainability. In addition, students are required to demonstrate the ability to analyze and propose interventions that improve power and privilege in a context-specific issue related to sustainability. Anderson (2013) pushed the boundaries on values, arguing that identifying and understanding values is insufficient; rather, SFSE programs need to strategically support student development of values that are congruent with sustainability. Valley and colleagues (2018) highlighted the values and dispositions of critical reflection, collective action, and seeking balance as the implicit curriculum in SFSE. In the IFSTAL program, Ingram and colleagues (2019, p. 09) aim to develop "an attitude that seeks reconciliation or conflict resolution...to understand and potentially resolve different stakeholder perspectives within the food system."

Other concepts and competencies related to equity found in the ESD and SFSE literature are interpersonal skills, analysis, and the role of interventions and transformational change. Interpersonal competency, which has been identified as a key competency in sustainability education (Brundiers and Wiek, 2017; Engle et al., 2017; Lozano et al., 2017; Wiek et al., 2011), can be broadly defined as "the ability to work well in teams and with a range of stakeholders" (Brundiers and Wiek, 2017, p. 1). Skills in cross-cultural communication and empathy (Wiek et al. 2011) are also related to equity. Additionally, analysis of issues related to the structure of the food system, as well as the identity, position, and agency of various food system actors are relevant (Galt et al. 2013; Meek et al. 2019). Meek and Tarlau (2015, 2016), highlighting the role of class and income, call attention to the structural nature of racial inequality within the food system, and center the role of education as a mechanism for creating transformational change. These authors, in addition to a brief mention by Valley and colleagues (2018), are the only (to the authors' knowledge) to specifically acknowledge *racial inequity* in the SFSE literature. While there are multiple ways in which equity-related concepts, skills, and attitudes are discussed in the SFSE and related literature, an explicit focus on equity appears absent.

Methods

To determine the extent to which SFSE programs for undergraduate (major and minor) and graduate (Masters and Ph.D.) degrees in the United States and Canada explicitly focus on equity, three researchers conducted an online search for program descriptions, program learning outcomes (PLOs), curriculum statements, and required course descriptions and syllabi (where available) in SFSE

degree programs. To build our sample, we started with lists of food systems programs that had been compiled by professional organizations (Sustainable Agriculture Education Association, Agriculture Food and Human Values Society, Canadian Association for Food Studies, and the North America Food Systems Network). To supplement this list, we found additional programs compiled by Hartle and colleagues (2017) that focused on interdisciplinary food-related academic programs in the U.S. To determine whether a degree program fell under the umbrella of SFSE, we employed broad inclusion criteria. Programs were included if their online program descriptions, LOs, and/or required courses indicated interdisciplinarity. We excluded programs that focused on single food system disciplines (e.g. agricultural, plant, soil sciences, nutrition and dietetics, food science, agricultural economics), those with absent or limited information on the degree programs, and those that had been discontinued. We excluded community college programs, tribal colleges, certificates, and concentrations within a department for comparability within the sample. Canada does not have the same structure of community colleges that the U.S. does, and limiting our sample to institutions where a four-year course of study is possible meant that more opportunities for courses focused on equity might be available. Most community colleges in the U.S. offer two-year Associates degrees. Excluding community colleges and tribal colleges might skew our findings away from examples of explicit equity-related competencies. We return to this limitation in the discussion.

Program descriptions, core coursework, and program learning outcomes (where available) for all programs in our sample were entered into NVivo 12.0 and

reviewed for statements that relate to equity or equality as a component of the degree program. Through this review, we assigned universities one of three ratings: (1) no mention of equality or equity in any materials that were reviewed; (2) descriptive *equality domain statements* (**Table 1**), (3) descriptive *equity domain statements* and/or specific mention of social group, such as racial, gender, or socioeconomic inequity with explicit descriptors of the nature or extent of the inequity (**Table 2**).

Textual analysis of source materials indicated key distinctions between equality and equity framing. **Table 1** provides excerpts from materials that exemplify the types of equality statements pulled from program descriptions, PLOs, and course descriptions. Equality type statements focus on more abstract and generic concepts of sustainability such as integrating social, economic, and environmental concerns; an appreciation for diversity of cultures, perspectives, and preferences; ethics and civic engagement; and interventions that focus on universal outcomes related to education, community, and/or food systems. Often, these equality statements lacked descriptive elements that identified how a universal approach would address systemic issues facing specific social groups who are most impacted. **Table 2** shows sample equity statements pulled from program descriptions, PLOs, and course descriptions. Equity-related terms spanned the following categories: institutional or systemic forms of oppression and marginalization based on gender, race, class/socio-economic, ethnicity; food justice and/or food sovereignty; unequal power relations; and developing attitudes and motivations towards personal action in addressing inequity.

Table 1: Sample equality domain statements from SFSE Programs in the U.S. and Canada. DOI: <https://doi.org/10.1525/elementa.428.t1>

Equality Concepts & Discourses Employed	Sample Program Description	Sample PLO	Sample Course Description
<ul style="list-style-type: none"> • Food (in)security • Cultural • Political • Social • Economic • Environmental • Diverse • Livelihood • Urban/Rural • Multicultural • Inclusive • Civic Engagement • Civic Responsibility 	<p>The sustainable food systems program focuses on sustainable food production, food preparation and processing, distribution, nutrition, and community food security in order for students to better understand how food systems influence health.</p>	<p>Foster commitment to ethical behavior and appreciation for diversity, global cultures, traditions and perspectives.</p>	<p>Social and cultural, economic, policy, and environmental factors in the community influencing nutritional status, and public health, techniques to assess community nutritional needs, and methodology for designing, implementing, and evaluating community nutrition programs, practices, and policies. Major service-learning project completed for a public or private agency.</p>
	<p>Sustainable food systems integrate these elements in such a way as to create an environmentally, economically, socially, and nutritionally healthy system that serves the needs of human and non-human communities for this and future generations.</p>	<p>Students will develop an awareness of the meanings of food among different cultures, and explore the ways in which geographic, cultural, political, and economic forces interact to influence food preferences, health, and nutritional status.</p>	

Table 2: Sample equity domain statements from SFSE Programs in the U.S. and Canada. DOI: <https://doi.org/10.1525/elementa.428.t2>

Equity Statements & Discourses Employed	Sample Program Description	Sample PLO	Sample Course Description
<ul style="list-style-type: none"> • (In)Equity • (In)Equality • Food Sovereignty • Discrimination • (Anti)Oppression • Marginalization • Social Justice • Food Justice • Environmental Justice • (In)Just(ice) • Socioeconomic (in)Equity • Gender/Sexism • Race(ism) • Ability (physical, mental) • Sexual Orientation (homophobic, transphobic) 	<p>This program is designed for students who seek to shift global, industrial food systems towards more equitable, just, and sustainable foodways. Food justice can be measured through a community's ability to acquire healthy food (food access), and its right to define its own food systems (food sovereignty). Students should also tailor their assignments in all courses to ensure that they deepen their understanding of how institutional racism and classism prevent certain communities from accessing healthy and culturally appropriate food so that sustainable food systems solutions can be developed.</p> <p>In what ways have poor people and people of color been historically dispossessed and marginalized in the food system?</p>	<p>Identify, analyze, and evaluate contemporary and historical factors that affect food supply and food security, including environmental issues and issues of power and social justice (e.g., labor, economic, environmental, racial and gender equity).</p> <p>Develop personal ethics that motivate action to alleviate injustice and exploitation in food systems.</p>	<p>If food is a basic human right, how do societies create universal access to food? What is the moral ethical basis for making citizens food secure in an age of global inequality? To what extent does providing food access need to consider cultural appropriateness, nutrition, and sustainability, and justice?</p>

Table 3: SFSE degree programs in the U.S and Canada with **equality** in program descriptions or core coursework. DOI: <https://doi.org/10.1525/elementa.428.t3>

	Total number	Percentage (%)
<i>Sustainable food system degree programs^a</i>	108	
Food system degree programs that mention equality	42	39
Graduate programs (N = 29)	10	34
Bachelor's levels programs – majors (N = 79)	25	32
Bachelor's levels programs – minors ^b (N = 79)	7	9

^a Total number of universities = 89.

^b Universities with programs that offered both a major and minor were counted as one degree program.

Results

We analyzed 108 food system degree programs from 89 universities, with a variety of degree names (e.g., sustainable food systems, agroecology, sustainable agriculture, food studies, see Tables 9 and 10 in appendix). The review of program descriptions, PLOs, core courses, and 13 available syllabi found that 72 universities (81%) had no explicit mention of equity in their core courses or their public facing program descriptions. However, **Table 3** indicates that 39% of degree programs assessed referenced equality and associated terms. Within these degree programs, the majority (76%) were undergraduate degree programs (majors and minors), with 24% being graduate programs.

Exploring findings related to equity, **Table 4** shows that 18 programs (17%) have some form of equity within

the materials examined. Of programs surveyed, six programs (6%) had specific references to racial equity with only undergraduate degree programs (majors and minors) represented (**Table 5**). Similarly, we found three degree programs (3%) specific to gender equity with presence in undergraduate programs (**Table 6**) and five degree programs (4%) referencing socioeconomic equity in one graduate (Master's) and four undergraduate (major and minor) programs (**Table 7**). Results indicate that no doctoral programs explicitly mention equity in the documents surveyed.

This review of programs was limited by what was available in public-facing program descriptions, PLOs, and course syllabi. It is possible that equity is included in more programs, but not specifically mentioned in the course

Table 4: SFSE degree programs in the U.S and Canada with **equity** in program descriptions or core coursework. DOI: <https://doi.org/10.1525/elementa.428.t4>

	Total number	Percentage (%)
<i>Sustainable food system degree programs</i>	108	
Programs that mention any form of equity	18	17
Graduate programs (N = 29)	6	21
Bachelor's levels programs – majors (N = 79)	10	13
Bachelor's levels programs – minors (N = 79)	5	6

Table 5: SFSE Degree Programs in the U.S and Canada referencing **racial equity** in program descriptions or core coursework. DOI: <https://doi.org/10.1525/elementa.428.t5>

	Total number	Percentage (%)
<i>Sustainable food system degree programs</i>	108	
Programs that mention racial equity	6	6
Graduate programs (N = 29)	0	0.0
Bachelor's levels programs – majors (N = 79)	3	4
Bachelor's levels programs – minors (N = 79)	3	4

Table 6: SFSE Degree Programs in the U.S and Canada referencing **gender equity** in program descriptions or core coursework. DOI: <https://doi.org/10.1525/elementa.428.t6>

	Total number	Percentage (%)
<i>Sustainable food system degree programs</i>	108	
Programs that mention gender equity	3	3
Graduate programs (N = 29)	0	0.0
Bachelor's levels programs – majors (N = 79)	1	1
Bachelor's levels programs – minors (N = 79)	2	3

Table 7: SFSE Degree Programs in the U.S and Canada referencing **socioeconomic equity** in program descriptions or core coursework. DOI: <https://doi.org/10.1525/elementa.428.t7>

	Total number	Percentage (%)
<i>Sustainable food system degree programs</i>	108	
Programs that mention socioeconomic equity	5	5
Graduate programs (N = 29)	1	3
Bachelor's levels programs – majors (N = 79)	2	3
Bachelor's levels programs – minors (N = 79)	2	3

syllabi. It is likely that our estimates of coverage are conservative; yet the fact that equity-related topics were rarely found in program descriptions, PLOs, or course descriptions is revealing.

Discussion

Food systems education programs have the potential for creating the formal and informal conditions required for emancipatory and transformative pedagogies (Anderson

et al., 2019). Our review of the literature found scholarship identifying the importance of ethical and value-based competencies in food systems programs (Engle et al., 2017; Galt et al., 2013; Wiek et al., 2011). Anderson (2013) wrote about the need for understanding rights-based approaches in SFSE, which provides a useful framework for understanding inequities and helps to encourage students to interrogate why even wealthy countries with abundant food supplies have food-insecure populations.

Food and nutrition security are understood in almost every country to be a human right, and inequitable realization of rights is closely associated with poverty and discrimination based on race, gender, and socioeconomic status.

In our program review, the limited number of educational programs explicitly stating equity terms (17%) potentially indicates a significant gap between the knowledge, skills, and attitudes being called for by food justice scholars and activists and the educational outcomes associated with institutions responsible for preparing future professionals. The prevalence of educational programs reviewed that incorporate equality domain language (39%) is much higher, which may result in similar challenges and critiques that have been directed at efforts to achieve food justice through one-size-fits-all approaches.

Universalism and disregard of racializing processes have been shown to be a key discursive strategy (Guthman, 2008) when positing knowledge as the limiting factor to addressing social inequity. Meek and Tarlau (2015) state that racial inequality may be perpetuated through ongoing and pointed silence, or a lack of incorporating racial difference and the historic configurations that result in contemporary inequities in food systems education. Results from a recent sociological study suggest that groups who “hold strong abstract commitments to norms of colorblindness and egalitarianism” are more likely to be persuaded by appeals that subtly invoke racial stereotypes (i.e., dog-whistling) (Wetts and Willer, 2019, p. 10). An explanation offered by the authors is the tendency towards avoiding discussion and self-censoring among individuals who hold norms of “colorblindness.” Possible results are the inability to trace negative outcomes to structural factors and being more vulnerable to appeals to latent racial stereotypes. Essentially, using vague equality terms and avoiding difficult topics, such as racism, patriarchy, classism, and other forms of structural oppression in SFSE programs, may leave graduates vulnerable to rhetoric that invokes harmful stereotypes and being persuaded to support and propose activities that perpetuate, rather than address, forms of oppression.

It is important to note that we do not believe it is fair or accurate to state that the presence of vague equality terminology in program or course descriptions means that those instructors and programs would be classified as holding norms of “colorblindness.” Due to the current political polarization on North American campuses, programs and instructors may intentionally use vague language to prevent trolling of faculty members by well-funded conservative networks. Or, instructors may wish to keep neutral language in course descriptions to prevent discouraging students from either side of the identity-politics spectrum from enrolling in a course, while still engaging with equity-related topics in class.

Our findings indicate that there are programs whose public facing documents have explicit attention to unequal power relations and associated structural inequalities (policies, institutions, cultures) in gender, race, economic status, ability-level, labour, space, and social status, food justice, and food sovereignty. However, key gaps remain in programs employing discourses of anti-oppression,

anti-racism, and decolonization (Lawrence and Dua, 2005; Morrison, 2011) or of intersectionality (Anderson et al., 2019; Crenshaw, 1989). Leibowitz and Bozalek (2016) suggest that academic areas for which inclusion of social justice is “going against the grain” are ideal for increased research in scholarship of teaching and learning. We would like to see more research to understand what kinds of teaching and learning related to equity and the food system are effective, and the recognition that critical scholarship is vital, given the prevalence of inequity in the food system. Simply including some mention of racial inequity and intersectionality will be insufficient to prepare students to help transform the current food system.

Equity competency model

In this section, as a starting point towards increasing the explicit integration of equity in SFSE programs, we propose declarative and procedural elements of an equity competency model. It is our hope that our model will be shared, critiqued, adapted, and integrated into SFSE programs to support constructive alignment among learning outcomes, teaching and learning activities, and assessment strategies, within individual courses and across degree programs. As stated by the Center for Social Inclusion (Giancattarino and Noor, 2014, p. 29) “thinking about how to transform structural racial inequity in the food system may seem overwhelming. But if we understand some definitions and use some simple tools we can find solutions that are indeed transformative.” We believe the same transformation in SFSE programs is possible.

Our equity competency model (**Table 8**) for SFSE programs builds upon equity-related competencies from four publications in the ESD literature and five publications in the SFSE scholarship as outlined in earlier sections of the paper. In addition, we searched for literature related to equity competency development in higher education more broadly to supplement the ESD and SFSE literature. We integrate statements related to domain-general competencies from the Association of American Colleges and Universities (AACU, 2014a, b) and diversity education; multicultural, diversity, and social justice competencies articulated in domain-specific fields of counselling, social work, planning, and nursing; and, guidelines developed by the Center for Social Inclusion, a non-profit organization working towards dismantling racial inequity in the food system.

Our equity competency has four domains: Awareness of Self; Awareness of Others and One’s Interactions with Them; Awareness of Systems of Oppression; and Strategies and Tactics for Dismantling Inequities. The third column of **Table 8** indicates congruence between the dimensions of our model and related literature. Our competency model shares commonalities with most multicultural, diversity, and social justice frameworks. In particular, we claim that students need to recognize their own values, beliefs, and assumptions, as well as their social location(s), as a necessary internal first step, which can then extend to recognizing the worldview of others, and identifying how social identities impact collaborative work. In addition, most competency frameworks, but not all, identify the

Table 8: Domains of an Equity Competency for SFSE. DOI: <https://doi.org/10.1525/elementa.428.t8>

Domains	Knowledge, Skills, Attitudes and Practices	Connections to Related Literature ⁶
Awareness of Self	Become aware of one's own assumptions, values, and beliefs that contribute to personal biases (implicit and explicit)	1,3,4,5,6,7,9,12,13,14,17,18
	Understand one's own social and cultural locations and related identities and group memberships, and how these relate to working with others	1,2,3,4,5,6,7,9,17
	Practice preventative self-care in order to remain productive and constructive	11
Awareness of Others and One's Interactions with Them	Recognize the assumptions, values, and beliefs that contribute to others' personal biases (implicit and explicit)	1,3,4,5,6,7,9,10,14,16,17
	Recognize the extent to which socio-cultural structures and values may oppress, marginalize, alienate, or enhance privilege and power in others' lives	3,4,5,6,7,8,13,15,17
	Tailor communication strategies to effectively express, listen, and adapt to others to establish relationships to further collective action	1,2,3,5,6,7,9,10,13
Awareness of Systems of Oppression	Identify historical and current systemic inequities (e.g. organizational, institutional, legal, and legislative) that affect different social groups and individuals	3,4,5,6,7,12,15
	Describe how policies impact racial equity in the food system	15,18
	Examine current and historical systemic expressions of racism and its intersections with class, gender, and other forms of systemic oppression in the food system	3,5,6,7,12,15
Strategies and Tactics for Dismantling Inequity	Build awareness of historical and current strategies and projects of resistance at the individual and collective scales	12,14,15,17
	Identify potential policy solutions and strategic opportunities to create a more racially equitable food system	2,5,6,7,18
	Use knowledge of the effects of oppression, discrimination, and historical trauma to guide the co-development of socially just planning and interventions	4,5,6,7,9,10,12,18
	Assess community assets and needs in ways that gather information, increase participation, and strengthen social cohesion, ensuring community needs are centred	5,6,7,12,15,17
	Co-formulate strategies and tactics with affected individuals and groups to set goals, generate program ideas, make organizational decisions, respect differences in communication and conflict styles, and take steps for collective action	2,3,5,6,9,12,15,17

⁶ Equity and Social Justice Related Competency Literature GroupingsDomain-General Competency

1. Intercultural (AACU, 2014b)
2. Civic Engagement (AACU, 2014a)
3. Puntaney, 2016 (*Multicultural Education*)
4. Chun and Evans, 2016 (*Diversity/Cultural Competency*)

Discipline-Specific

5. Ratts et al., 2016 (*Multicultural Counseling*)
6. Core Competencies for Social Work Education (*Council on Social Work Education*)
7. Agyeman and Erickson, 2012 (*Planning*)
8. Cohen and Gregory, 2009 (*Nursing*)

ESD Literature

9. Lozano et al., 2017
10. Engle et al., 2017
11. Brunders and Wiek, 2017
12. Habron, 2012

SFSE Literature

13. Galt et al, 2013
14. Anderson, 2013
15. Meek and Tarlau, 2016
16. Francis et al., 2018
17. Valley et al., 2018

Center for Social Inclusion

18. Giancatarino and Noor, 2014

need to include, collaborate with, and consider the perspective of socially diverse participants representing historically oppressed communities when formulating plans and strategies for addressing issues and working towards solutions (Nassar-McMillan, 2014).

Declarative elements of the equity competency model

Declarative knowledge – the terms and concepts within each domain – is the foundation of our equity competency model. Students need to develop a vocabulary and understanding of key terms first in order to effectively address equity-based issues. Examples of key terms in the Knowledge of Self domain are values, beliefs, assumptions, implicit/explicit bias, and social location. Examples of key terms in the Systemic Inequities content area are racism, structural racism, discrimination, intersectional oppression, and white supremacy. Due to the varied use of terms related to equity in popular culture, students may have strong prior beliefs about a particular term that can act as a barrier to learning, and subsequent collaboration and problem solving. For example, in discussing race and inequity in the food system, a necessary interrogation of “whiteness”, “white privilege” and “white supremacy” may be deemed racist by students who identify as white because they may believe it is singling out a specific group based on perceived common physical characteristics. However, the use of these terms is not racist according to the scholarly definition of racism: “an ideology of racial domination in which the presumed biological or cultural superiority of one or more racial groups is used to justify or prescribe the inferior treatment or social position(s) of other racial groups” (Clair & Denis, 2015, p. 857). Identifying and analyzing white supremacy to better understand the distributive, procedural, and epistemic injustices in the food system does not prescribe the inferior treatment of “white” individuals. Rather, the open discussion of white supremacy reveals empirically measurable patterns of structural inequity in areas of concern such as food insecurity, distribution of environmental pollution, and access to and representation in positions of power (Alkon, 2008; Alkon and Agyeman, 2011; Gibb and Wittman, 2013; Lachance et al., 2014).

Further important examples of declarative knowledge in the Systems of Oppression content area pertain to current and historical expressions of structural racism, such as the establishment of land-grant universities through the sale of expropriated tribal lands through the Morrill Act (Lee and Ahtone, 2020); Black, Hispanic, and Native American farmers being excluded from Farm Service Agency benefits; the on-going colonization and oppression of Indigenous peoples in Canada through the Indian Act; and the Canadian Chinese Head Tax (1885–1923) (BC Ministry of Interior and Trade, n.d.). Issues relating to the rights of women, LGBTQ2+ communities and disabled people, in addition to other oppressed and marginalized communities, also reveal patterns of inequity. The incorporation of these topics into food and health-related curricula, although not traditionally considered relevant to courses in the natural sciences, demonstrates the systemic

and persistent social conditions that impact and prevent the development of sustainable food systems for all. We are not insisting that natural science courses become quasi-history or quasi-sociology courses; however, each region of North America (regrettably) has numerous examples of current and historical expressions of oppression that illustrate food-related inequities. A strong grounding in these expressions of oppression, and the strategies employed to overcome them, can help to move toward stories of resistance and resilience by marginalized communities.

Procedural knowledge in the equity competency model

Procedural knowledge refers to one’s “ability to execute action sequences to solve problems” (Schneider et al., 2011, p. 1). In our competency model, the strategies and tactics content area focuses on processes to promote equity in food systems through integrating declarative knowledge from the three other content areas when engaging with problems or addressing issues. As our review of the SFSE literature, program descriptions, and syllabi indicated, there is limited focus on understanding historical and current systemic inequities and their intersections as they relate to the unequal distribution of harms and benefits in food systems; the lack of representation by diverse stakeholders in decision-making processes; and the disappearing, exclusion, or under-valuing of different ways of knowing beyond a techno-scientific worldview in society. In the strategies and tactics for dismantling inequity domain of our model, the explicit emphasis on these characteristics, which are often absent or understated in other competency frameworks, would require students to apply knowledge and skills from the first three domains to a context-specific food system issue. To illustrate how procedural knowledge could potentially be applied we return to one of the scenarios we introduced at the beginning of the paper. We believe the discussion of this scenario helps demonstrate how an equity competency is best understood and expressed as a context-specific performance (Wilhelm et al., 2019) as well as how the embodiment of an equity competency is fundamental to doing food justice work.

Scenario 1 (involving Chinese-Canadian seniors) was an actual event that took place in 2014, in which elderly Chinese women in a low-income neighbourhood of Vancouver² were accused of taking advantage of hunger-relief programs by “double-dipping”, i.e., returning to get a second meal in different clothing and packing the food in take-away containers. White men who were also in line to receive meals complained to service providers and became openly aggressive towards the elderly women due to the perceived dishonesty (Huang et al., 2014). One possible solution to prevent this type of unfair distribution of meals would be to set up a system of accountability such as a tracking system that ensures each individual only receives one meal per visit. An intervention of this nature would likely result in an increase in capital and labor costs for the organization, but also demonstrate to all individuals in line that equal distribution of meals is a priority. It would potentially decrease the incidence of “double-dipping”

and aggression in line, satisfying the white men who raised the concern and protecting the elderly Chinese women. Initially, this solution seems reasonable and fair. However, this approach insufficiently takes into account implicit issues of inequity; and, although the intervention may address the perceived issue, it will likely further entrench and reproduce historical injustices and struggles between social actors in this scenario.

The story of how this real-life scenario was resolved reveals the importance of developing an equity competency in SFSE education. The agencies providing the meals recognized that the language differences between staff (predominantly English speakers) and the Chinese seniors (predominantly Cantonese speakers) were a barrier to a more in-depth understanding of the situation. Three students from the University of British Columbia Urban Ethnographic Field School were asked to engage with clients accessing the meal services. The three students, fluent in Cantonese, Mandarin, and English, conducted ethnographic observations, focus groups, and one-on-one interviews (Huang et al., 2014). Their observations confirmed that racial tensions existed between Chinese women and white men. Their findings revealed that the claims reported by white male users about Chinese seniors, particularly women, were true. Some seniors were often receiving a meal and returning in different clothes to receive a second portion. Conversations with Chinese seniors also confirmed this practice. The reason for changing clothes before returning for another meal was to minimize the aggressive behaviour of the white men who noticed them. The reason for coming back for a second meal and packing it away was to bring food to members of their community who were unable to physically leave their homes or wait in line-ups due to health limitations, or to feed their grandchildren. Essentially, these Chinese women were helping address issues of food access in their community for a segment of the population whose needs were not being met by the non-profit organizations and government services tasked with their care. Furthermore, these elderly Chinese women were experiencing threats of violence for their care work.

Having uncovered the reasons for this “dishonest” behavior of the Chinese seniors, the students made recommendations to the service providers to change their hiring criteria to include more diverse language skills, to better assess the needs of the community for which they are mandated to serve to include individuals with barriers to mobility, and to develop regular opportunities for Chinese and other ethnicities to engage with each other to promote socializing between users.

Although this scenario does not explicitly connect all domains of our proposed competency model, it does highlight the power of an equity lens in understanding, assessing, and taking action in a food systems context. Issues of white supremacy emerged in terms of whose account of the situation was initially taken seriously (white men), the composition of the management of the service provider, and whose language held positional power (English). Issues of historical beliefs about Chinese-Canadians as being deceitful and untrustworthy (Gibb and Wittman,

2013) contributed to the need for rectifying the issue of “double-dipping”, magnified by a general distrust of individuals experiencing poverty in the Downtown Eastside of Vancouver (Miewald and Ostry, 2014). Gender relations and threats of violence were leveraged as social power and women's role as care-givers in the domain of food (Allen and Sachs, 2012) was not initially recognized or considered. Furthermore, the absence of concern for individuals with mobility challenges who were experiencing poverty also was not evident in the description of the situation. Had the service provider gone ahead with a possible strategy of monitoring each client so that each received the same portion, this would have exemplified an equality approach. The approach and recommendations of the students came from a deeper understanding of equity.

Similar to the framing on multicultural and social justice counselling competencies articulated by Ratts and colleagues (2016), equity competency development in SFSE programs is presently aspirational, yet ultimately essential for authentic food system transformation. We recognize that the knowledge and skills embedded within our framework are best regarded as part of a life-long iterative process of growth. Additionally, there is a risk of perceiving and expecting a linear process to competency acquisition within a degree program. As expressed by Chun and Evans (2016, p. 37) in reference to cultivating diversity competence in an educational setting, human development is complex and involves consideration and recognition of “situational influences and the diversity of developmental outcomes among individuals from differing cultures.” Intersectional equity work is not a destination but a journey. Alongside steady commitment and progress, students and faculty alike will make mistakes. Developing an equity competency requires the commitment to an ongoing practice of vulnerability, empathy, and patience with oneself and others on this journey. The other two introductory scenarios, developing influential food system reports and policy, and the design, implementation, and evaluation of national food access strategies, have similar racial and intersectional issues of equity.

One example of a food systems transformation initiative centered around equity has been pioneered by Food Solutions New England (FSNE), a regional network with a shared vision for their region to build the capacity to produce at least 50% of its food by 2060 while supporting healthy food for all, sustainable farming and fishing, and thriving communities (Donahue et al. 2014). As a backbone organization for FSNE, the University of New Hampshire provides critical support for the network and is an exemplar in showing how partnerships between higher education institutions and their surrounding communities can both transform food systems and allow students to use their earned and learned educations in ways that contribute to diverse communities. FSNE is leading the way in realizing racial equity and food justice with their 21 Day Racial Equity Habit Building Challenge,³ now in its seventh year. During the challenge, registered participants receive a daily prompt with a reading, video, or audio file designed to deepen understanding of and willingness to confront racism and work to build more effective social

justice habits, particularly those dealing with issues of race, power, privilege, and leadership. Participants contemplate the prompt and then participate in discussions in a variety of fora. The challenge is designed to help participants discover how racial injustice and social injustice impact the food system, to connect with one another, and to identify ways to dismantle racism and become better leaders for a more just and equitable food system. Groups, organizations, schools, and agencies take on the challenge collectively. As an example, the University of New Hampshire launched a local version of the challenge in 2019. An honors class on food, power, and social justice at the University of Southern Maine undertook a community engagement project in 2018 that focused on the Challenge. Students learned about the fundamentals of a more sustainable food system and inclusive community and developed skills in reflecting upon personal perspectives, cultural practices, barriers, and opportunities that build equity, and also in applying methods and tools to realize more complete participation in our food system for a healthy and fulfilling life (Spiller, K., personal communication).

As noted in the limitations of our sampling method, some community colleges; tribal colleges; and non-profit advocacy and educational organizations (e.g., United Farm Workers, the Higher Education Consortium for Urban Affairs, the Working Group on Indigenous Food Sovereignty, Race Forward) have a history of centering social justice and equity in their programs. Historically Black Colleges and Universities and Historically Latino College and Universities in the U.S. are well positioned to teach about equity from within populations that experience the consequences of inequity in the food system. SFSE programs at the university level can learn from, collaborate with, and integrate successful practices from those who have a track record of success and are grounded in the lived experience of systemic forms of oppression. As is the case with the authors of this article, the social locations and unearned privilege bestowed upon professors and instructors in institutes of higher education varies and limits the understanding of the intersectional nature of inequities experienced in food systems and beyond. In this way, we can broaden our recognition and representation of who is considered an “authority”, and whose experiences, knowledge(s), and ways of being are legitimate and worthy of inclusion in the development of future professionals in food systems. The results of our assessment of SFSE programs indicates that our universities have room for improvement and growth in this area.

Conclusion

How SFSE programs prepare their graduates for professional work in the food system matters. If our sample of public-facing program websites, PLOs, and core courses are representative of the *explicit* attention to equity in the larger set of SFSE programs, it is unlikely that future professionals will have the capacity to help dismantle systemic inequities, and may result in the re-entrenchment of on-going forms of oppression. Being intentional in our classrooms and programs will not transform food systems

on its own, but it is an important way to focus attention and energy.

Our findings indicate a clear need for equity to be explicitly integrated in required courses in SFSE programs. The results of the review of universities in the U.S. and Canada with food system programs revealed a need for more scholarship of teaching and learning to understand how programs can adequately integrate issues related to equity, and specifically racial equity. SFSE programs have a responsibility to both inspire and equip students so that as professionals, they can address food system inequities in the process of transforming our food systems towards sustainability. As an effort to further develop transformation in SFSE, we propose an equity competency model with declarative and procedural elements across four domains that build upon many existing elements in SFSE programs: awareness of self, awareness of others and one's interactions with them, awareness of systems of oppression, and strategies and tactics for dismantling inequity. We conclude with a call to action for faculty, practitioners, and students to incorporate an equity lens into their practice and studies. First and foremost, program directors, professors, and instructors teaching in SFSE programs should review their program learning outcomes and core courses, and if they already integrate equity-related content, they should consider adjusting their public-facing documents to be more explicit. If content of this nature is minimal or absent, they should consider ways to embed it, ideally across several courses in the curriculum for reinforcement. For those who already incorporate content and activities related to our equity competency model in the educational practice, we recommend collecting evidence of effectiveness and sharing broadly through scholarly and public forms of dissemination.

The work of realizing equity is difficult but essential. Faculty, practitioners, and students fall across a continuum in realizing equity. We can work together to build faculty and student will, skill, and capacity to address racism and other forms of oppression, share resources and support others in their journeys, facing both challenges and opportunities. Together we become a community working towards equity wherever we live and work; in all disciplines and professions. We then are pathing the way for a culture of belonging to thrive, and more sustainable, just, and active learning communities to evolve. Sources of inspiration abound, from universities, community-based organizations, and networks leading the way, to resources that can support faculty, practitioners, and students along the continuum (Farrell et al., 2017; Food Solutions New England, 2018; Holt-Giménez, 2016; Rodman-Alvarez and Colasanti, 2019; Tener, 2019).

Notes

¹ For SAEA's Equity Statement, visit <http://www.sustainableaged.org/saea/equity-statement/>.

² Although the intersectional nature of the scenario reveals historical and current expressions of systemic oppression among settler and immigrant populations, it is important to acknowledge that the context in which this scenario took place is on the traditional, ancestral, and unceded homelands of the

x^wməθk^wəyám (Musqueam), sḵwḵwú7mesh (Squamish), and selílwitlh (Tsleil Waututh) Nations. Unceded means that Aboriginal Title to this land was never surrendered, relinquished, handed over, or acquired by the Crown. Therefore, the government of Canada has no ownership of the land upon which Vancouver exists.

³ For details on the program, visit <https://sustainable-unh.unh.edu/racial-equity-challenge>.

Supplemental file

The supplemental file for this article can be found as follows:

- **Appendix Table 9.** SFSE Undergraduate Programs – United States of America and Canada – 2019 Snapshot. DOI: <https://doi.org/10.1525/elementa.428.s1>
- **Appendix Table 10.** SFSE Graduate Programs – United States of America and Canada – 2019 Snapshot. DOI: <https://doi.org/10.1525/elementa.428.s2>

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The authors have no competing interests to declare.

Author contributions

- Substantial contributions to conception and design
 - WValley, MAnderson, ESterling, EBetley, SAKabas, NTBlackstone, PKoch, CDring, JBurke, KSpiller
- Acquisition of data
 - MAnderson, CDring
- Analysis and interpretation of data
 - WValley, CDring, MAnderson, ESterling, EBetley, NTBlackstone
- Drafting the article or revising it critically for important intellectual content
 - WValley, MAnderson, ESterling, EBetley, SAKabas, NTBlackstone, PKoch, CDring, JBurke, KSpiller
- Final approval of the version to be published
 - WValley, MAnderson, ESterling, EBetley, SAKabas, NTBlackstone, PKoch, CDring, JBurke, KSpiller

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