



## Discussion paper

## Complexity of occupational health in the hospitality industry: Dynamic simulation modeling to advance immigrant worker health



Sevil Sönmez<sup>a,\*</sup>, Yorghos Apostolopoulos<sup>b,c</sup>, Michael Kenneth Lemke<sup>b,c</sup>, Yu-Chin (Jerrie) Hsieh<sup>d</sup>, Waldemar Karwowski<sup>e</sup>

<sup>a</sup> Rosen College of Hospitality Management, University of Central Florida, Orlando, FL, USA

<sup>b</sup> Complexity & Computational Population Health Group, Texas A & M University, College Station, TX, USA

<sup>c</sup> Department of Health & Kinesiology, Texas A & M University, College Station, TX, USA

<sup>d</sup> Department of Hospitality & Tourism Management, Rochester Institute of Technology, Rochester, New York, USA

<sup>e</sup> Department of Industrial Engineering and Management Systems, University of Central Florida, Orlando, FL, USA

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## ABSTRACT

Hispanic immigrant workers, who are heavily employed in low-skill/low-wage lodging and foodservice jobs, work in environments that induce disproportionate health and safety risks. Traditional research approaches have produced only partial insights into the risks of Hispanic immigrant hospitality sector workers, failing to fully capture the underlying dynamic, structural, and systemic complexity of hospitality worker health. This paper has three objectives: (1) to outline the multifaceted and disproportionate health and safety risks of these workers; (2) to introduce a systems paradigm with potential to contribute to more promising approaches in occupational health and safety research in tourism and hospitality; and (3) to elaborate on how computational simulation modeling can fortify occupational health and safety research in tourism and hospitality, and offer a heuristic example of a risk prevention model among Hispanic immigrant hospitality workers rooted in a stakeholder-based system dynamics modeling approach.

## 1. Introduction

The importance of employee health to the labor-intensive hospitality sector cannot be overstated. Overall injury rates are highest for hotel housekeepers and acute trauma rates are highest in kitchen workers and housekeepers (Buchanan et al., 2010). In addition, turnover rates of the hospitality industry's lodging and restaurant sectors have been increasing over the last several years (56.6% in 2010, 66.7% in 2014, 72.1% in 2015) (Ruggles, 2016). Fortunately, there is growing awareness of the importance of employee health; over 90% of 500 business leaders surveyed believe that promoting wellness can affect employee productivity and performance, as well as employee morale, benefits cost reduction, and safety (HERO, 2015).

Many low-skill/low-wage jobs held by hospitality industry workers require long hours, are physically demanding, pose health and safety risks, and are disproportionately staffed of minorities and immigrants (Lee and Krause, 2002; Marco-Lajara and Úbeda-García, 2013; Sanon, 2014; Watson, 2008; Wial and Rickert, 2002). As the travel and tourism industry experiences continued significant growth, its accommodations

sector remains under pressure from increasing competition, high turnover rates, high profits, low-cost productivity, and seasonal demand (Freedman and Kosová, 2014; Marco-Lajara and Úbeda-García, 2013; Watson, 2008). In response to these pressures, the restructuring, consolidation, and other cost-reducing practices of the accommodations sector (e.g., hiring agency workers on H-2B Guest Worker Visas) (Sanon, 2014) have exacerbated the already endemically poor health of its labor force (Freedman and Kosová, 2014; Lee and Krause, 2002), with pronounced consequences for its immigrant and minority workers (Wial and Richert, 2002). Hispanic immigrant workers in particular, who are heavily employed in low-skill jobs in lodging and foodservice,<sup>1</sup> work in environments that induce an array of disproportionate health risks (Brownell, 2008; Hsieh et al., 2013, 2015a,b; Karatepe and Tizabi, 2011; Ross, 2005), as compared to non-immigrant workers in diverse occupations (Loh and Richardson, 2004; Pransky et al., 2002). Due to the significant size of the Hispanic immigrant population in the U.S., its large presence in the accommodation and foodservice sectors, and due to the significant health concerns of this population, the focus of this paper will be on Hispanic immigrants rather than on immigrant

\* Corresponding author.

E-mail address: [sevil.sonmez@ucf.edu](mailto:sevil.sonmez@ucf.edu) (S. Sönmez).

<sup>1</sup> Hospitality sector workers may be used interchangeably throughout this paper with lodging, accommodations, hotel, and foodservice workers.

workers in general. It is important to point out that health, labor, immigration, and economic problems are experienced by a number of different immigrant populations (e.g., Asian, Caribbean, Hispanic, African) to different degrees and require research attention; however, the inclusion of all these populations is beyond the scope and focus of this paper.

Immigrant workers' efforts to adapt to ongoing stressors—precarious employment that carries hazardous exposures, weak bargaining power, low wages, and limited health insurance benefits—exacerbated by depressed living conditions related to immigrant status, have contributed to multisystemic physiological dysregulations and associated comorbidities, including obesity, atherosclerosis, hypertension, and cardiometabolic disorders (Ward et al., 2010; Benach et al., 2010; Davies, 2009).

Traditional research approaches, grounded in linear causality and reductionism, have generated fragmented insights into the work conditions of hospitality sector workers (Marco-Lajara and Úbeda-García, 2013) and health risks of Hispanic immigrant lodging and foodservice workers (Krause et al., 2010; Minkler et al., 2010). This is primarily due to the fact that these studies have examined individual pieces of the problem and overlooked interactions among factors while also ignoring the temporal connections and delayed effects of work policies and conditions. Not only have these traditional approaches failed to fully capture the underlying dynamic and systemic complexity of immigrant hospitality worker health, but also their quantitative analytical techniques have been unable to fully describe health risks and identify efficacious interventions. In contrast, approaches that draw on a synergy of systems (Aldrich, 2008; Lich et al., 2013; Lich et al., 2014; Sturmburg and Martin, 2013), syndemic (Singer, 2009), and socioecological theories (Krieger, 2012), that incorporate sociostructural factors in their etiological models (Belkić, 2000; Karasek, 2008; Siegrist, 1996), and that are grounded in dynamic modeling (Sterman, 2000; Byrne and Callaghan, 2013) can provide a framework to explicate risks of Hispanic immigrant hospitality workers, lead to more effective interventions, and potentially alleviate the burden for hospitality and healthcare sectors (Cook and Rasmussen, 2005).

In this paper we: (1) outline the multifaceted and disproportionate health risks of Hispanic immigrant lodging and foodservice workers; (2) propose a systems paradigm that can contribute to more promising approaches for occupational health and safety research in hospitality; and (3) explain how computational simulation modeling, with an emphasis on system dynamics, can help plow new ground in occupational health and safety research in the hospitality sector. Toward this final objective, a heuristic example is offered of a health risk prevention model among Hispanic immigrant hospitality workers that can emerge from a participatory modeling process.

## 2. How policy and work organization shape hospitality worker health

In developed countries, health disparities are often rooted in interrelated differences in social status, income, ethnicity, nativity, and geography (Peters et al., 2008). In the U.S., immigrants experience a disproportionate health burden compared to non-immigrants (Edberg et al., 2010; WHO, 2016). Hispanic immigrants in particular are faced with excess levels of overweight/obesity, hypertension, cardiovascular disease (CVD), stroke, and diabetes (Edberg et al., 2010). Pronounced occupational health disparities have also been recorded between immigrant and non-immigrant populations, as immigrants working in risk-laden environments (e.g., construction) have been linked with excess injury and fatality rates (Brunette, 2004; Grzywacz et al., 2012a; Grzywacz et al., 2012b). Hispanic immigrants—often found in temporary, hazardous, and low-skill/low-wage jobs—face excess injury and fatality risk, with rates twice those of non-Hispanics (Benach et al., 2010; Loh and Richardson, 2004). In many countries around the world, immigrant seasonal laborers (e.g., agriculture) often fill “3D jobs”

(dangerous, dirty, degrading) that carry high risk for hazardous exposures, injury, and death (Benach et al., 2010), have difficulty accessing care and compensation when injured, and have weak bargaining power to demand better work conditions (Briggs, 2009; CAPIT, 2014; Community Catalyst, 2009; Davies, 2009; Stimpson et al., 2013; Zallman et al., 2015).

About half of the immigrants in the U.S. work in service or blue-collar occupations (Ahonen et al., 2007), a large proportion of whom are undocumented (Rivera-Batiz, 1999; Ennis et al., 2011). Of all undocumented immigrants, 22% are in professional, business and other services (e.g., landscaping) (NCLR, 2011), 18% work in hospitality sector jobs (BLS, 2016) [sector accounts for over 14.3 million jobs in U.S.], and 16% are in construction (BLS, 2016). In fact, more than half of undocumented immigrants are employed in these three sectors combined, compared with only 31% of native-born U.S. workers (Brown et al., 2007). Adverse work conditions and low-skill requirements of lodging and foodservices in particular tend to overwhelmingly attract vulnerable workers, such as immigrants and minorities. Overall, minorities account for more than 60% of hotel and restaurant workers (NCLR, 2011), and Hispanics are found more often than other ethnic groups in hotel housekeeping and foodservice jobs (25.3% of total employed in the U.S.) (BLS, 2016). Additionally, agency-hired workers on temporary contracts—representing a contingent workforce that has grown to approximately one third of the U.S. workforce—serve as a consistent, economical, and accessible labor pool for the hospitality sector (Sanon, 2014) and are at higher risk for occupational injuries (Buchanan et al., 2010; Virtanen et al., 2005).

Shaped by an array of social, immigration, labor, economic, and health policies, low-wage Hispanic immigrant lodging and foodservice workers live and work in stressogenic and pathogenic environments that generate disproportionate health risk (Benach et al., 2010; Edberg et al., 2010; Schenker, 2010). Compared to other occupations, a sizeable increase in occupational stress has been recorded in the hospitality sector over the past 15–20 years (BLS, 2016; O'Neill and Davis, 2011). Low-paying hospitality sector jobs (e.g., lodging, foodservice) are characterized by unfavorable conditions that not only adversely affect workers' health (Hsieh et al., 2013, 2014, 2015a,b; Karatepe and Tizabi, 2011; Ross, 2005; Pienaar and Willemse, 2008; Wial and Richert, 2002) but present serious challenges for human resource management (Marco-Lajara and Úbeda-García, 2013; Watson, 2008). Hotel workers consistently experience physical (e.g., musculoskeletal injuries); chemical (e.g., exposure to toxic cleaning solutions); biological (e.g., exposure to microbial contaminants); and psychosocial hazards (e.g., long/irregular work hours) (Shani and Pizam, 2009; Willemse, 2006), work stress/time pressures (Chiang et al., 2010; EASHW, 2010; WorkCover, 2003), work-home conflict (Hsieh et al., 2008; Kim, 2008; Wong and Ko, 2009), job insecurity (Gautie, 2010), as well as interpersonal conflict and discrimination (Krause et al., 2010). For foodservice workers, these include: physical (e.g., burns from hot oils); chemical (e.g., carcinogens/mutagens found in fumes when preparing foods under high temperatures); biological (e.g., foodborne organisms); environmental (e.g., slippery floors, environmental tobacco smoke, falls, contusions); and psychosocial hazards (e.g., work stress, discrimination) (Tsai, 2009; Tsai and Salazar, 2007; Woo and Krause, 2003). Entrenched in this context, Hispanic immigrant workers are faced with multisystemic physiological dysregulations or excess *allostatic load* (AL) accumulation (Salazar et al., 2016). AL is known to contribute to high levels of overweight/obesity (RWJ, 2014), hypertension (AMA, 2013; Sorlie et al., 2014), and hyperlipidaemia (AMA, 2015), as well as cardiovascular (AMA, 2015), and metabolic (Mattei et al., 2010) diseases in this population (AMA, 2013; Khatri et al., 2013; Beckie, 2012; BLS, 2016; Ennis et al., 2011; McClure et al., 2015).

*Allostasis* is the body's dynamic regulatory process that maintains physiological stability in response to acute stress, whereas *AL* is the cumulative, multisystemic (metabolic, cardiovascular, and immune)

dysregulation resulting from exposure to chronic stress (Sun et al., 2007). *AL* is a summary measure of the physiological “wear and tear” the body experiences from ongoing stress and is further affected by health-damaging behaviors (e.g., diet, lack of exercise, sleep/circadian disruption from shiftwork, alcohol, smoking, social isolation), ultimately resulting in pathology and chronic illness (McEwen, 2004; McEwen and Stellar, 1993; McEwen and Seeman, 2008; Seeman et al., 1997). The longitudinal, nonlinear, and reciprocal nature of *AL* accumulation (Read and Grundy, 2012; Seeman et al., 2010; Wiley et al., 2016) challenges researchers to go beyond traditional methods to not only understand but to mitigate the problem before it manifests in morbidity and mortality.

Immigrant communities characterized by socioeconomic and health disparities are at greater risk for *AL* accumulation than non-immigrants (Beckie, 2012; Turner, 2016; Turner and Avison, 2003). Because immigrant workers are overrepresented in lower socioeconomic strata (Edberg et al., 2010), they typically find themselves in the lower range of skill and income distributions; are forced to accept undesirable jobs (Schenker, 2010); live in poverty due to inadequate wages (Rivera-Batiz, 1999); face job, housing, and food insecurity (Schenker, 2010); have limited or no access to healthcare; face abuse and exploitation; and experience social exclusion (Benach et al., 2010). Undocumented immigrants, in particular, experience the added fear of deportation risk and separation from family members (Grzywacz et al., 2010; McKanders, 2011). Not surprisingly, documentation status has a major exacerbating effect on all of the foregoing sources of stress. Furthermore, the lack of documentation gives employers and supervisors a means to control, exploit, and intimidate workers into accepting dangerous work conditions (De Castro et al., 2010a,b; Krause et al., 2002) while leaving undocumented workers vulnerable to mistreatment or abuse (Calnan et al., 2004; Poulston, 2008). There is substantial evidence that high-pace and low-skill occupations (Sun et al., 2007), workplace unpredictability, and lack of social and legal protections (McEwen, 2004), together with documentation status are associated with increased risk for *AL* accumulation and a wide array of far-reaching health problems (De Castro et al., 2010a,b; Gamperiene et al., 2006; O’Campo et al., 2004; Sales and Santana, 2003; Zock, 2005).

The collective influence of foregoing multilayered, sociostructural domains—from immigration and labor policies to work and nonwork environments—produce acute and chronic stress over time. Protracted stress and resulting physiological dysregulations have been shown to depress the immune system (Taylor et al., 1997) and offer a valid explanation for how adverse and interacting life and work conditions contribute to excess disease trajectories (Sun et al., 2007; Taylor et al., 1997). When *AL* remains for prolonged periods outside the range of values considered normal, it can lead to the various health problems noted earlier and ultimately to death (Bellingrath et al., 2009).

Along with sociostructural factors, *AL* has been linked with adverse work conditions (Schnorpfeil et al., 2003), stressful work environments (Hansen et al., 2009), and job insecurity (Beckie, 2012) as well as lower decision latitudes, higher job demands (BLS, 2016), greater effort-reward imbalance, vital exhaustion, and burnout (Bellingrath et al., 2009). Prolonged exposure to such adverse work conditions can trigger physiological, behavioral, emotional, or cognitive reactions, leading to anxiety, depression, burnout, substance abuse, and other mental health problems (Burgel et al., 2010; Leka and Jain, 2010). Considering the foregoing, it is understandable that Hispanic immigrants employed in low-skill/low-wage lodging and foodservice jobs face multiple *AL* triggers.

Preventive interventions for immigrant worker health have generally overlooked the importance of interacting sociostructural factors (e.g., social, labor, immigration, labor policies) and work organization that have marked the wellbeing of working populations over time—including those few designed to advance the health and safety of Hispanic immigrant hospitality workers (Krause et al., 2010; Minkler et al., 2010). Grounded in health education and training, studies with

farmworkers (Grzywacz et al., 2013; Quandt et al., 2001; Quandt et al., 2013), poultry workers (Marin et al., 2009), cleaners (Rasmussen et al., 2012), construction workers (Arcury et al., 2012; Brunette, 2005), kitchen workers (Minkler et al., 2010), and hotel room cleaners (Krause et al., 2010) have proposed a variety of low-leverage intervention programs including assessment of job factors, health and safety training for employees and employers, community-based participatory interventions, educational and training materials, as well as testing the efficacy of extant safety interventions. The inadequacy of immigrant worker education alone and the need for greater enforcement of regulations and involvement of policymakers have been acknowledged by only a few (Grzywacz et al., 2013; Quandt et al., 2001, 2013).

### 3. Systems paradigm in hospitality worker health research

The health risks of Hispanic immigrant hospitality workers can be conceptualized as a complex system comprised of a large number of heterogeneous, interactive, and adaptive components. These factors can be broadly classified under four thematically distinct, multilevel domains: (1) *Government and industry policies*: immigration, labor, social, and health factors and mechanisms that shape the wellbeing of immigrant lodging and foodservice workers over time (e.g., deportation policies, enforcement of national labor laws, access to social services, affordable healthcare access) (Benach et al., 2010); (2) *Work and non-work environments*: intertwined multilayered contexts grounded in work organization and content on the one hand and living conditions and constraints on the other—both shaped by broader public and private/corporate policies (e.g., precarious working conditions, wage/hours manipulation, depressed neighborhoods, social exclusion) and can regulate population health risks (Brown et al., 2007); (3) *Health pathways and embodiment*: immediate and time-delayed individual responses to chronically stressogenic environments, such as behavioral (e.g., overeating), physiopathological (e.g., hypertension), and emotional/psychosocial (e.g., depression) changes and reactions (Sorlie et al., 2014); and (4) *Health outcomes*: obesity, hypertension, hyperlipidaemia, and related cardiometabolic disorders; mental health issues (e.g., anxiety, depression) (Karatepe and Tizabi, 2011).

In contrast to traditional occupational epidemiology and prevention approaches grounded in reductionism and linear causality, Hispanic immigrant hospitality worker health is characterized by circular causality (in the form of *feedback loops*), where an initial factor ripples through a chain of causation over context, space, and time influencing and being influenced by, several distinct (yet linked) factors (Sterman, 2000). These multilayered and multilevel clusters of factors exhibit bidirectional exchanges (Sterman, 2000; Homer and Hirsch, 2006), where decentralized elements within each cluster influence other elements or systems within and across other clusters over time. These constant feedbacks and complex dynamics result in adaptation and co-evolution among included components, where the system self-organizes and produces unpredictable bottom-up outcomes that exhibit *emergence*. Outcomes are said to *emerge* from the interactions of factors to produce novel and often-unexpected patterns and properties, which are difficult to predict or accurately understand using linear approaches (Styhre, 2002; Wu et al., 2014).

The following example illustrates the intricacies of reciprocal feedbacks, self-organization, and emergence in *Hispanic immigrant hospitality worker health*: changes in labor policies (e.g., federal government extends minimum wage protections to immigrant workers) would result in perturbations throughout the system of Hispanic immigrant hospitality worker health, and subsequently result in a range of cascading changes, from economic-level consequences, such as employer adaptations (e.g., further pressuring workers to work “off-the-clock”) to individual-level consequences, such as worker adaptations (e.g., possible pursuit of unionization). Moreover, the variety of “responses”/ripples resulting from a change in minimum wage protections would consequently lead to additional “feedback” to policymakers, who may have



to create and/or adapt additional legislation in response.

These cyclical causal relationships continue with each change at any level—hence, the term *feedback loops*. Thus, circular action chains continue in perpetuity, or until the system changes via gradual or abrupt shifts, or *phase transitions* (Scheffer, 2009). *Phase transitions, or tipping points*, occur when forces within the system reach a critical threshold; once this happens, the state of the system changes. The susceptibility of a system to phase transitions is contingent upon its *resilience* (or stability) when shocks or disruptions are imposed upon it (Holling, 1973). *Resilience* and *phase transitions* represent critical considerations for efforts to modify systems. Resilient systems may rebuff efforts to intervene, resulting in intervention failures; however, interventions that strategically induce desirable phase transitions can generate exponential, cascading, and sustainable changes throughout a system.

Such architecture contains characteristics of a *complex adaptive system* (CAS), exemplified by nonlinear (non-proportional), adaptive, and dynamic interactions among its parts, and the generation of self-organizing, non-reductive, unpredictable phenomena (Gatrell, 2005; Miller and Page, 2007). Within this complex adaptive system, individual clusters, elements within various clusters, and smaller or larger subsystems exhibit similar attributes themselves (Sturmborg and Martin, 2013). These characteristics necessitate the conceptualization of immigrant hospitality worker health as a *complex adaptive system of systems* (CASoS) (Glass et al., 2011). Figs. 1a and 1b present simplified conceptualizations of immigrant hospitality worker health. The contrasting difference between the two diagrams is dynamic complexity. Fig. 1a illustrates the socioecological influences on Hispanic immigrant worker health grounded in linear causality, whereas in Fig. 1b it is grounded in circular causality, exemplified by circular causal interactions in the form of feedback loops across contextual and spatiotemporal scales.

These complex, adaptive, and emergent attributes of immigrant hospitality worker health require an ecological and dynamic conceptualization. Current mental, theoretical, and conceptual models in occupational health and safety research are incompatible with the dynamic complexity that characterizes hospitality worker health. For example, extant mental models are often overly narrow regarding the breadth of causal influences and they often underestimate the time horizons across which such problems unfold (Stermann, 2012). Similarly narrow are theoretical and conceptual models, which tend to embody the limited mental models held by the researchers who create them. Conceptual and theoretical models are usually static (Higgins, 2002), in contrast to the temporal dynamics (e.g., adaptation, phase transitions) that underlie dynamic complexity (Miller and Page, 2007). Further, these models are often defined by assumptions of linear cause-and-effect, which contrast non-proportionality (Marshall et al., 2015) and circular causality (Stermann, 2000), which underpin the causal forces within CASoS. Moreover, the prevalent linear and reductionist quantitative methodology and analytical techniques, which seek to maximize internal validity via various forms of observational designs, cannot capture macro-/meso-structural domains and contextual or ecological effects that unfold across different spatiotemporal boundaries. In analytical terms, and based on probability theory and macroscopic laws of averages, the dominant “general linear model” (GLM)<sup>2</sup> (Abbott, 1988) has guided immigrant hospitality worker health research, as it is the case with social sciences in general. The regression-modeling underpinning analytical approaches grounded in the GLM, however, is fundamentally incapable of handling feedback loops or other nonlinearities (i.e., critical transitions) (Luke and Stamatakis, 2012) where a relatively

small input in the system of immigrant hospitality worker health (e.g., extension of Occupational Safety and Health Administration [OSHA] laws to protect undocumented immigrant workers) can induce disproportionately large effects (e.g., sweeping introduction of safety protections for all workers in the hospitality sector). Even advanced analytical techniques, such as structural equation modeling or latent class analysis, are not designed to capture these nonlinear properties due to the fundamental limitations of the GLM (Galea et al., 2010). Simply put, traditional statistical modeling, or any reductionism-grounded approach, cannot effectively help to identify, model, capture, control, manage or explain CASoS (Castellani, 2014), such as immigrant hospitality worker health.

While heavily restricted by the limitations of reductionism and the GLM, immigrant hospitality worker health research has generated important, yet incomplete, insights into occupational safety and health risks, evidenced by modest successes in impacting overall risk burden beyond short periods of time and narrow demographics. Thus, efforts to create sustainable population-wide changes are restricted by inherent shortcomings in the employed science since they are based on a partial understanding of immigrant hospitality worker health and omit complex, dynamic, and emergent sociostructural forces and spatiotemporal scales that exert profound influences in shaping risk burden. These paradigmatic shortcomings have led to incommensurability between epistemology and reality (Kuhn, 2012)—with *linear and reductionist assumptions and the true nature of immigrant hospitality worker health being fundamentally different*—therefore necessitating a paradigm shift. The introduction and integration of a complex systems paradigm, which represents a new way of thinking with new concepts, theories, and methods in occupational health and safety in the hospitality sector, has the potential to forge new research, policy, and practice directions. Such a paradigm would be grounded in: (a) the synergy of ecosocial (Krieger, 2001), syndemic (Singer, 2009), social ecological (Stokols, 1996), and complex systems (Bar-Yam, 2002; Kernick, 2006; Kremser, 2011) schools of thought; (b) the integration of social, health, natural, and computational sciences; and (c) the advantages of computational simulation modeling.

While this “complexity turn” (Urry, 2005) can make great contributions to theory development, research, and policy in immigrant worker health in general and in hospitality in particular, it is the advent of computational modeling and simulation that can trigger groundbreaking developments—as it has been the case with other social systems (McDaniel and Driebe, 2001; Plsek and Greenhalgh, 2001; Rouse, 2008; Litaker et al., 2006; Paley, 2010). The notion that we cannot truly understand complex social phenomena, such as Hispanic immigrant worker disease burden, until we can reproduce their causes is not new (Epstein, 2006). Modeling and simulating complex systems allows us to grow social structures *in silico*, demonstrating that certain sets of micro-specifications are sufficient to generate macro-phenomena of interest (Epstein, 2006). While we have long referred to the systemic and complex elements of Hispanic immigrant worker health, its effective modeling and eventual delineation has been an elusive endeavor. The investigation of problems that exhibit organized complexity has only recently been made feasible by the proliferation of computational advances (Wilson and Holt, 2001; Wu et al., 2014).

Dynamic simulation modeling methodologies enable us to overcome shortcomings of existing mental, conceptual, and theoretical models, thus allowing us to foresee novel events that these models cannot predict (Chahal et al., 2013; Stermann, 2012; Lane and Husemann, 2008). These approaches explicitly incorporate the aforementioned characteristics and elements of dynamic complexity, providing researchers with the methodological and analytical means to broaden mental models, enrich existing theories, generate new theories, explore novel research questions, and seek limitless possible solutions, all while embracing the CASoS that shape immigrant hospitality worker health. Further, dynamic simulation models can capture vexing nonlinearities by including hypothesized causal factors across multiple levels and

<sup>2</sup> “The ‘general linear model’ linearly transforms causality in social systems, and its assumptions—such as assuming entities are fixed and have attributes that are independent of context or history—are fundamentally incompatible with reality of complex social systems” (Abbott, 1988, p. 169), such as immigrant worker health.

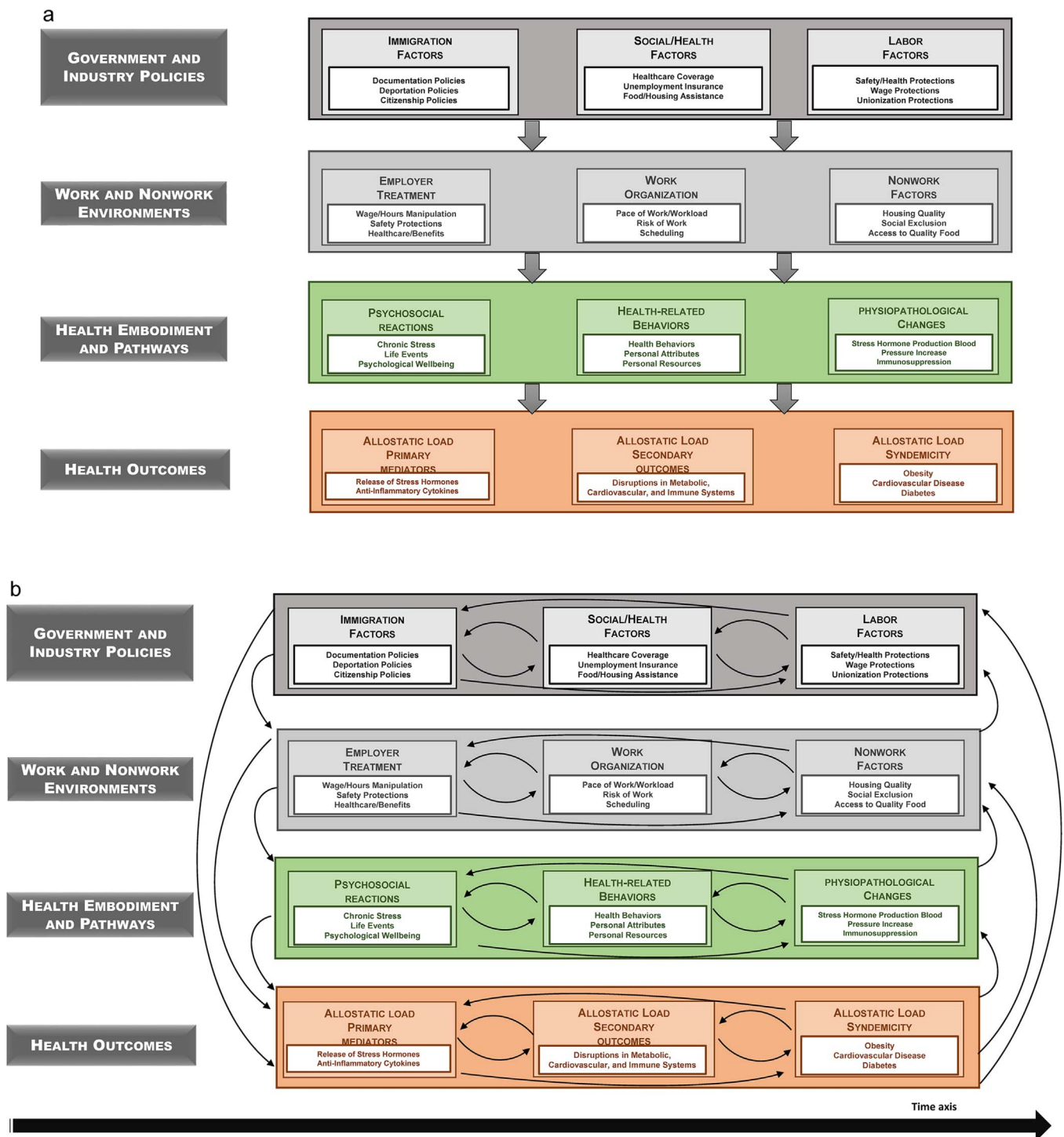


Fig. 1. a) Hispanic immigrant worker health grounded in linear causality. b) Hispanic immigrant worker health grounded in circular causality.

spatiotemporal scales, their interrelationships, feedbacks and interactions, and they can provide insights into the emerging aggregate patterns that these systems produce (Serman, 2012; Faezipour and Ferreira, 2013). In many ways, simulation models are a more flexible structural model form than regression, as they can be tested and fit to data as with regression models. With simulation models, however, the effort is to simulate mechanistically, instead of trying to “control for” background noise and bias to accurately estimate the effect of causal factors. In addition, simulation models go beyond trying to predict or estimate relationships, which are the foci of regression models, and instead are generated to emphasize understanding and especially to

inform action. In this way, they provide a framework for assessing, organizing, and synthesizing research across multiple systems (e.g., worker disease distribution) and approaches (e.g., data obtained using different methodologies and analytical techniques). Further, because dynamic modeling and simulation can function as a virtual world, limitless counterfactual scenarios can be tested in controlled experiments (Homer and Hirsch, 2006; Serman, 2000).

Despite the clear benefits and implications of leveraging dynamic simulation modeling methodologies, research and practice of Hispanic immigrant worker health has not tapped into its potential. Computational modeling has been used in immigrant worker health

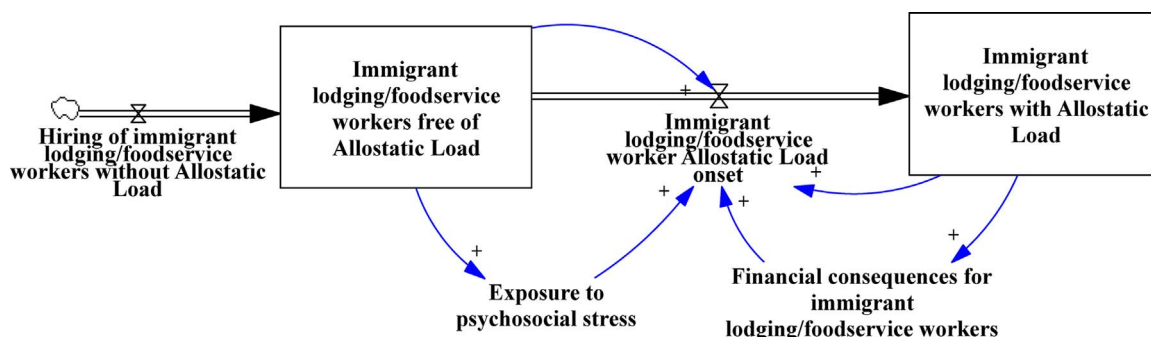


Fig. 2. Model of simple stock-and-flow structure in Hispanic immigrant worker health.

research (i.e., Anderson et al., 2007; Zhang and Jager 2011), but it has remained largely underdeveloped, has not been integrated into comprehensive conceptual frameworks and research designs, and remains inadequately grounded in socioecological frameworks. As a result, modeling methodologies have been mechanistic and compartmentalized, instead of being integrated with the epistemology of immigrant worker health research, with these few intriguing but sporadic examples. At the other end of the spectrum, an exhaustive literature search on simulation modeling applications in occupational health and safety research in hospitality brought to light only two conference presentations that initiate an exploratory discussion on the advantages of complex systems in this line of scholarship (i.e., Sönmez et al., 2016; Zhang et al., 2016).

#### 4. Dynamic modeling in hospitality worker health research

There has been a recent explosion in the applications of dynamic simulation modeling in population health and health services research (i.e., Homer and Hirsch, 2006; Milstein et al., 2010), with few applications in occupational health and safety (i.e., Liu et al., 2015). Three such methodologies are well suited for and commonly applied to these types of problems: system dynamics modeling (Sterman, 2000; Homer et al., 2004; Lane and Husemann, 2008), discrete event simulation (Marshall et al., 2015), and agent-based modeling (De Marchi and Page, 2014). They are used to design and develop mathematical representations (i.e., formal models) of the operation of processes and systems to experiment with and test interventions and scenarios and their consequences over time to advance the understanding of the system or process, communicate findings, and inform management and policy design (Marshall et al., 2015).

In the case of occupational health in hospitality sector workplaces, the use of system dynamics (SD) can foster an initial, broad, and aggregate understanding of the underlying causal web of immigrant worker health risks. SD can help to map and model diverse forces of change so that mutual influences on and direction of immigrant hospitality worker health can be better understood and governed. It is very different from traditional approaches in Hispanic immigrant worker health research, as SD: (1) starts from theory, diverse stakeholder input, and available data to assemble *visible dynamic hypotheses* about the behavior of a system over time in the form of diagrams and models (Sterman, 2000); (2) utilizes the values and insights of community stakeholders (i.e., hotel managers, government policy makers, unions) in a *group model-building process* (Hovmand, 2014); (3) builds differential-equation-based mathematical models that manifest causal processes, rather than statistical models correlating health risks to outcomes (Sterman, 2000); (4) analyses mathematical models via computer simulations to gain insights into system behavior over time and to formulate insights on gathering supplemental data to test the model with different assumptions (Sterman, 2000); and (5) uses models to design interventions and to gather additional data with the purpose of pursuing realistic model elaborations that pass a variety of

verification and validation tests (Lich et al., 2014).

SD models explain causality differently from traditional statistical models, which are based on data fit. In SD, the behavior of a system is predicated on its structure and is not due to external forces. Instead, the emphasis is placed on the *endogenous sources* of its behavior and the interactions of the factors (variables) inside the model boundary (smallest number of components that define the model's scope and where dynamic behavior is generated as it arises within its internal structure) are believed to generate the observed dynamics (Richardson 2011). System structure is based on the interplay of *stocks* (accumulation of system elements, e.g., healthy hospitality workers), *flows* (rates at which quantities are added to or subtracted from stocks over time, e.g., number of workers at risk per year), and *auxiliary variables* (potential causal factors, e.g., long workhours in hotels) exhibiting direct, indirect, and often circular (rarely proportional to cause) causal relationships (or *feedbacks*) over time. Simulation, in the form of counterfactual experimentation for the production of optimal results, is used to track stock accumulations, determined by flows, feedbacks, and time delays. Fig. 2 presents a simple stock-and-flow structure in immigrant hospitality worker health, using AL onset and accumulation as an example associated with the excessively stressogenic environment these workers are exposed to.

The structure of Hispanic immigrant hospitality worker health is defined by its feedback structure where hypothesized causal factors are connected by arrows, with annotations about polarities and time delays (Sterman, 2000). When a path originates at any factor, traces from arrow to arrow, and returns to the original factor, it forms a *feedback loop* (Sterman, 2000). Feedback loops can reinforce or oppose initial change in the revisited factor, with the former driving exponential growth and the latter bringing the system toward equilibrium (Sterman, 2000). They determine the behavior of a complex system, as key causal influences are embodied by dominant feedback loops (Sterman, 2000).

Fig. 3 presents a simple feedback structure in Hispanic immigrant hospitality worker health. A *reinforcing loop* (R) illustrates how *labor pool forces* can exacerbate psychosocial stress and induce AL onset, where increased AL onset leads to increased cardiovascular disease problems, which in turn triggers workforce attrition. Accelerated workforce attrition generates labor pool shortages that in turn, increase work demands—including a faster pace of work—on the existing labor pool, which then exacerbates psychosocial stress and AL onset. In contrast, a *balancing loop* (B) demonstrates how *employer policies* can control AL onset ramifications. As AL onset reduces workforce productivity, this is met with an increase in employer-initiated protections, which then reduce psychosocial stress and trigger AL onset. The trajectory of Hispanic immigrant worker disease burden can change dramatically based on which feedback loop becomes dominant at critical time periods. Since system behavior is predicated on the number, types, and strength of feedback loops, these can be seen as fighting for system control, with dominant loops determining the direction of a complex system. In this case, the goal is to leverage those feedback loops that either maintain a particular state or precipitate a change to an

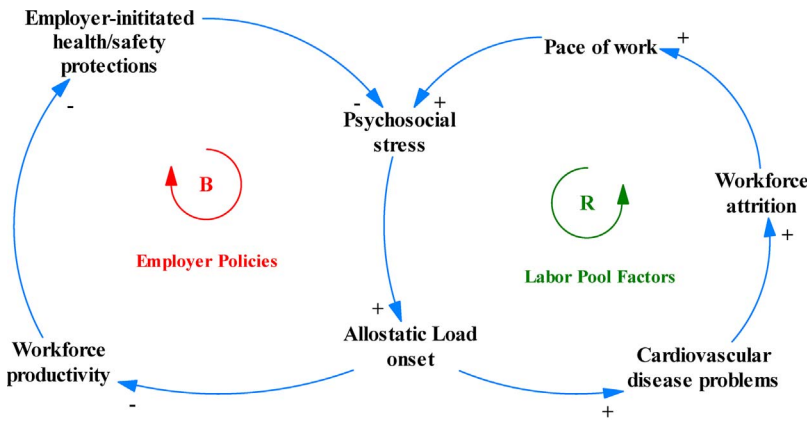


Fig. 3. Example of a model of simple stock-and-flow structure in Hispanic immigrant worker health.

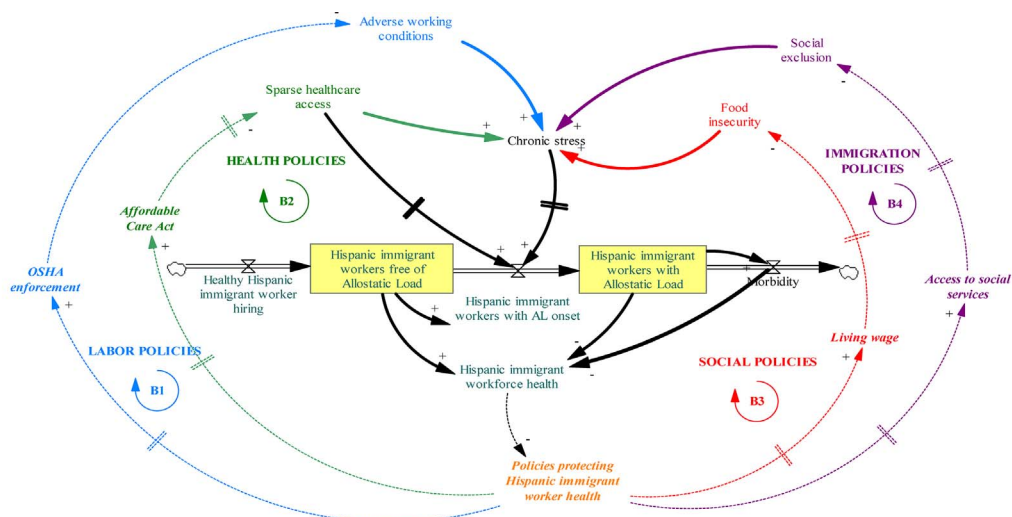
1. Factors at the arrow tail are assumed to causally influence factors at the arrow head
2. Polarities indicate direction of causal influence. Positive polarities indicate influence in the same direction, and negative polarities indicate influence in the opposite direction

improved and stable state of population wellbeing.

Fig. 4 presents a simplified SD stock-and-flow diagram of Hispanic immigrant worker health. It demonstrates how a SD model can help researchers overcome the limitations in their current mental models and assist in deconstructing the problem at hand and ultimately evaluating different policies. This small model is an example of what may emerge from an actual community-grounded model-building process. An actual model would have significantly greater detail and complexity, and as all models include uncertain assumptions, *uncertainty and sensitivity analyses* would be conducted to assess robustness of its conclusions (Sterman, 2000). Given this is a heuristic example for illustration purposes; only four factors among key potential factors influencing Hispanic immigrant worker health have been selected.

Fig. 4 presents a causal chain of stocks (rectangular boxes), flows (arrows with valves), and auxiliary variables forming *feedback loops B1, B2, B3, and B4*. These feedback loops illustrate how cascading outcomes may affect the health of the Hispanic hospitality immigrant workforce,

which in turn, will necessitate policies protecting Hispanic immigrant workers. Hypothetical examples might include enhanced OSHA enforcement, extension of the Affordable Care Act, implementation of a living wage, and increased access to social services—all of which have potential to curb immigrant worker health risk burden. The upper-central section of this model—connecting factors (*regular font*) with bold arrows—represents the *current state of Hispanic immigrant worker health* and, at the same time, the *emerging dynamic hypothesis* denoting that interacting labor, health, social, and immigration factors shape and perpetuate risk for AL onset among Hispanic immigrant workers. The upper-outer section of the model—connecting factors (*italics*) with dashed arrows—represents a *preventive scenario* that explains how interacting policies, organizational responses, and their aggregate capacity may prevent or reduce AL onset among Hispanic immigrant hospitality workers. Simply put, these domains function as pathways for moving the system into a more positive direction. The simulation and comparison of “*what-if?*” counterfactuals will aid in navigating policy



1. Balancing loop B1 (“Labor Policies”) illustrates how government enforcement of safety and health regulations can reduce adverse working conditions, which then reduces both chronic stress and allostastic load (AL) onset.
2. Balancing loop B2 (“Health Policies”) demonstrates how existing federal healthcare legislation can increase healthcare access, in turn reducing chronic stress and AL onset.
3. Balancing loop B3 (“Social Policies”) exemplify how policies that ensure a living wage can increase the food security of immigrant hospitality workers, which then reduces chronic stress, thereby reducing AL onset
4. Balancing loop B4 (“Immigration Policies”) shows how policies that increase access to social services can reduce social exclusion, which then reduces both chronic stress and AL onset.

Fig. 4. Model of simple stock-and-flow structure in Hispanic immigrant worker health.



configurations needed to trigger the most plausible responses, such as reduction of immigrant hospitality worker disease burden.

## 5. Conclusion

The wellbeing of the U.S. Hispanic immigrant workforce has wide-reaching repercussions for the welfare of the hospitality industry. The industry's growing attention to corporate social responsibility (CSR) (Holcomb et al., 2007; Krambia-Kapardis and Neophytidou, 2014) is focused mostly on charitable donations, environmental protection (Pérez et al., 2013), employee job satisfaction and wellbeing, organizational trust (Lee et al., 2013), and quality-of-life of local communities (Bohdanowicz and Zientara, 2009), and rarely on the occupational health of workers on whom it relies so heavily. Although the health of the labor force is linked to the economic health and sustainability of individual enterprises as well as the industry as a whole, when "health" or human resources are mentioned in CSR literature, it is economic health or employee attitudes that are the primary focus (Lynn, 2009).

Moving beyond the hospitality industry, as national health spending continues to soar, there exists a growing interest in workplace disease prevention and wellness programs to improve worker health and lower costs (Baicker et al., 2010; HERO, 2015). In fact, recent studies indicate that high-performing and well-managed companies invest in workforce health and wellbeing (Grossmeier et al., 2016). A meta-analysis of costs and savings associated with workplace wellness programs found that medical costs fall by about \$3.27 per every dollar spent on wellness programs and that absenteeism costs are reduced by \$2.73 for every dollar spent (Baicker et al., 2010). An evaluation of Johnson & Johnson Family of Companies' health promotion programs, revealed that the annual growth in total medical spending was lower than similar large companies and that employees saw reductions in obesity, blood pressure, cholesterol, tobacco use, physical inactivity, and poor nutrition (Henke et al., 2011). Further, Johnson & Johnson saved \$565 in average annual expenditures per employee and produced a return on investment equal to a range of \$1.88–\$3.92 saved for every dollar spent on the program (Henke et al., 2011). Such significant returns on investment denote that the wider implementation of these programs can have large benefits for budgets, help to improve productivity, as well as health outcomes (Baicker et al., 2010; Henke et al., 2011). Substantive efforts to improve worker health are long overdue, especially considering the over 14.3 million employed in the U.S. tourism and hospitality industry (BLS, 2016) and the 284 million employed globally in the travel and tourism industry (WTTC, 2016). It is important to note however, that innovative approaches need to be utilized in order to maximize the benefits of efforts so that meaningful change can be affected in the lives of millions of workers.

It is highly advisable for the accommodation and foodservice sector to seriously consider the value of genuine concern for employee health and substantive efforts to assure healthy and equitable workplaces and conditions to gain competitive advantage (Porter, 1985) over those organizations that neglect or exploit their employees. Organizations with employees, who are ill, injured, stressed, burned out, or depressed pay the costs of absenteeism and presenteeism (working ineffectively while sick), as well as high costs of workers' compensation and insurance. By reducing employee turnover, not only can organizations minimize their recruitment, retention, and training costs, they can also create goodwill and an image as an organization that cares about its employees—which is not only better for their bottom line, but worth far more than profits in the traditional sense. Furthermore, by creating a work environment that is more conducive to a healthy workforce (e.g., reduced stress, living wage, reasonable hours and workload), organizations can further reduce costs related to workers' compensation and insurance, as well as absenteeism and presenteeism due to injury or illness while also gaining competitive advantage over those organizations that fail to do so.

Within the context of Hispanic immigrant hospitality worker health,

interdependence, connectedness, diversity, and adaptation of causal factors generate dynamic complexity, and it is this complexity that necessitates a new paradigm in occupational health and safety research within this sector. If hospitality stakeholders wish to improve the health and wellbeing of immigrant workers, reduce disease burden, and ultimately see a more productive and financially viable workforce, the time is now to embrace innovative approaches. An application of the systems paradigm, grounded in socioecological and complex adaptive systems theories and dynamic modeling epistemology, can foster new directions in Hispanic immigrant worker health research and bring about positive population health and safety impacts. Community-based SD modeling can be used as a strategic tool in the quest for comprehensive understanding and impactful sustainable interventions to curtail the disease burden of Hispanic immigrant workers. Finally, it is our hope that this paper will serve as a catalyst for a long-overdue discourse on the role of a systems epistemology in hospitality scholarship, with anticipated practical benefits for workers, the industry, healthcare, and stakeholder communities.

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