



Health Disparities Of Latino Immigrant Workers In The United States

By: **Adam Hege**, Quirina M. Vallejos, Yorghos Apostolopoulos, and Michael Kenneth Lemke

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The purpose of this paper is to provide an overview of the literature pertaining to occupational health disparities experienced by Latino immigrant workers in the USA and to advance a general framework based on systems science to inform epidemiological and intervention research. Using papers and other sources from 2000 to the present, the authors examined the employment conditions and health outcomes of Latino immigrant workers and critically analyzed the pervasive evidence of health disparities, including causal mechanisms and associated intervention programs. The occupations, including the work environment and resultant living conditions, frequently performed by Latino immigrants in the USA represent a distinct trigger of increased injury risk and poor health outcomes. Extant intervention programs have had modest results at best and are in need of more comprehensive approaches to address the complex nature of health disparities. An integrated, systems-based framework concerning occupational health disparities among Latino immigrant workers allows for a holistic approach encompassing innovative methods and can inform high-leverage interventions including public policy. Reductionist approaches to health disparities have had significant limitations and miss the complete picture of the many influences. The framework the authors have provided elucidates a valuable method for reducing occupational health disparities among Latino immigrant workers as well as other populations.

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Health disparities of Latino immigrant workers in the United States

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Abstract

Purpose – *The purpose of this paper is to provide an overview of the literature pertaining to occupational health disparities experienced by Latino immigrant workers in the USA and to advance a general framework based on systems science to inform epidemiological and intervention research.*

Design/methodology/approach – *Using papers and other sources from 2000 to the present, the authors examined the employment conditions and health outcomes of Latino immigrant workers and critically analyzed the pervasive evidence of health disparities, including causal mechanisms and associated intervention programs.*

Findings – *The occupations, including the work environment and resultant living conditions, frequently performed by Latino immigrants in the USA represent a distinct trigger of increased injury risk and poor health outcomes. Extant intervention programs have had modest results at best and are in need of more comprehensive approaches to address the complex nature of health disparities.*

Practical implications – *An integrated, systems-based framework concerning occupational health disparities among Latino immigrant workers allows for a holistic approach encompassing innovative methods and can inform high-leverage interventions including public policy.*

Originality/value – *Reductionist approaches to health disparities have had significant limitations and miss the complete picture of the many influences. The framework the authors have provided elucidates a valuable method for reducing occupational health disparities among Latino immigrant workers as well as other populations.*

Keywords *Immigrants, Complexity, Health and safety, Disparities, Latino workers, Overview of literature*

Paper type *Research paper*

Introduction

There are approximately 25 million immigrant, or foreign born, workers in the USA, comprising over 16 percent of the total labor force (Bureau of Labor Statistics (BLS), 2013a). These workers are mainly employed in agriculture, forestry, fishing, construction, manufacturing, and service occupations and are exposed to a wide array of safety and health hazards (BLS, 2013b; McCauley, 2005). Existing evidence suggests that immigrant workers suffer excess occupational injury, morbidity, disability, and mortality compared to US-born (native-born) workers (Brunette, 2004; Orrenius and Zavodny, 2009; Zhang *et al.*, 2009).

Latinos comprise approximately half of the immigrant worker population in the USA (BLS, 2013a, b; McCauley, 2005) and are represented in a broad spectrum of occupations; however, they are especially represented in construction, agriculture, hospitality and other service and support occupations (Richardson *et al.*, 2003). As a result of their concentration in higher risk industries, they experience higher rates of morbidity, disability, and mortality compared with native-born and other immigrant workers (Orrenius and Zavodny, 2009). Moreover, because many Latino workers are undocumented, the tentative nature of their work arrangements renders them highly susceptible to safety and health hazards (McCauley, 2005).

Latino immigrant worker health research is mostly grounded in monocausal, compartmentalized, proximal, and medial conceptualizations and methodologies, with an emphasis on safety. Within this paradigm, prevalent low-leverage interventions have dealt only with the consequences (e.g. traumatic injuries) and not the underlying causes (e.g. long work hours) or the fundamental causes (i.e. inadequate labor legislation) of the excess burden, resulting in generally negligible outcomes for these workers. These continued emphases on reductionist epistemologies and methodologies, individual-/meso-level approaches, and low-leverage interventions denote a pronounced failure of systems thinking, given that hazards faced by Latino immigrant workers function as complex, dynamic, and oftentimes adaptive systems.

This paper elucidates occupational health and safety disparities of Latino immigrant workers in the USA. Specifically, we: first, present the demographic employment, compensation, and benefits characteristics of Latino immigrant workers; second, within an epidemiological framework, examine the evidence of the unequal distribution of diverse and interacting health and safety outcomes among Latino immigrant workers compared to native-born workers across different occupations; third, assess the state and efficacy of preventive interventions targeted at Latino immigrant workers; and fourth, propose a systems-based, integrative framework grounded in complexity and systems science to guide future health research and intervention efforts for Latino immigrant workers.

Methods

We used the electronic databases EBSCO, CINAHL, JSTOR, ProQuest Direct, PsycInfo, PubMed, and WorldCat and conducted two separate literature searches for articles published since 2000. This search was conducted from September 2013 until March 2014, and only articles pertaining to immigrant and foreign-born workers in the USA were included. Overall, over 250 articles were encountered and evaluated. Our literature search consisted of three primary phases. First, we used the following search terms in conjunction with “Latino”: farmworkers, construction workers, hotel workers, service work, poultry workers, restaurant workers, manufacturing workers, immigrant, health disparities, immigrant health, foreign-born/immigrant workers, occupational health disparities, and US immigrant workers health disparities to compile relevant literature pertaining to the demographics of Latino workers and their increased risk for occupational health disparities when compared to native-born workers. These searches were duplicated, supplementing the term “Hispanic” for “Latino.” Second, we conducted a search for articles depicting the use of interventions or policy within the realm of Latino immigrant workers in the USA. Keywords used in this search included the following terms: intervention, occupational health policy, occupational legislation, safety training, and prevention. These terms were searched in conjunction with the broad and specific occupational categories listed above. Third, the collection of articles gathered during the first two phases was supplemented by various searches on the World Wide Web using the search engines Google or Google Scholar and applying the same search criteria described during the previous steps above. The sites utilized for this portion of the literature review were the US Bureau of Labor Statistics (BLS), the US Department of Labor, the CDC/NIOSH, Farmworker Justice, the Pew Research Center, and the Migration Policy Institute. Based on the extant literature, most references relate to farmworkers and construction workers as they comprise the occupations that have been predominantly studied in relation to disparities experienced by Latino immigrant workers.

Demographics, employment, compensation, and benefits

Delineating the demographic and employment characteristics of non-Latino foreign-born workers in general – and Latino foreign-born workers in particular – comprises a great challenge for investigators of immigrant worker health. Because of the large number of undocumented immigrants who participate in the labor force and have legitimate reasons to fear revealing their personal information to government agencies, most official estimates of foreign-born workers are assumed to be low (McCauley, 2005; Orrenius and Zavodny, 2009). Much of the occupational health literature on immigrant workers relies upon estimates from the Current Population Survey (CPS), a monthly nationally representative survey that is sponsored jointly by the US BLS and the US Census Bureau.

Worker characteristics

There are an estimated 8.3 million undocumented workers in the USA (Passel and Cohn, 2012). Latino immigrant workers are a diverse demographic category, including workers from Mexico and other Central and South American countries. The 2002 National Agricultural Workers Survey estimated that only 5 percent of agricultural workers were indigenous (Carroll *et al.*, 2005). Among Latino farmworkers, an estimated 68 percent are born in Mexico (North Carolina Council of Churches, 2012). For most of the countries of origin of Latino immigrant workers, Spanish is the official language; however, there are population segments in many of these countries who mainly speak various indigenous languages. Data on immigrant Latino workers who are indigenous-language speakers are limited and vary by industry and the surveillance system used in each industry. A 2007 survey of farmworkers in North Carolina reported that 25 percent indicated they spoke an indigenous language (Arcury *et al.*, 2009, 2012). Latino immigrant workers tend to be younger than other racial/ethnic occupational groups: the median age of Latino workers is 26, compared to 38 for whites and 30 for African-Americans (Forst *et al.*, 2010; Orrenius and Zavodny, 2009). Latino immigrant workers tend to be less educated than the total workforce (BLS, 2013a, b; Orrenius and Zavodny, 2009).

The Pew Research Center estimates that in 2008, 17 percent of construction workers and 25 percent of farmworkers were undocumented (Passel and Cohn, 2012). Latino immigrants tend to work in blue-collar occupations that involve higher exposure to hazards than white-collar occupations (McCauley, 2005; Orrenius and Zavodny, 2009). Data from the 2011 CPS corroborate that 24.6 percent of foreign-born workers are employed in service occupations, such as food preparation, house-keeping, building and grounds-cleaning, and maintenance occupations, compared to 16.4 percent of native-born workers (Bureau of Labor Statistics (BLS), 2012b). Nearly 35 percent of the female foreign-born workforce was employed in service occupations, compared to 19 percent of the native-born workforce. Foreign-born workers are also more likely than native-born workers to work in production, transportation, and material moving occupations (15.8 and 11.0 percent, respectively) and in occupations involving natural resources, construction, and maintenance (13.5 and 8.5 percent, respectively) (BLS, 2012b). The majority of farmworkers are Latino, with approximately 53 percent undocumented, 21 percent legal permanent residents of the USA, and 25 percent US citizens (North Carolina Council of Churches, 2012).

Foreign-born workers make up a large proportion of the contingent workforce, including day laborers and other temporary workers (Leclere and López, 2012). Several industries employ large numbers of Latino workers on a temporary or contingent basis. Jobs in agriculture and construction are commonly short-term arrangements, in which it is common for a labor contractor to negotiate employment for a work crew. Contingent workers are more likely to be young, female, black, or Hispanic than permanent workers (Cummings and Kreiss, 2008). Approximately 75 percent of day laborers are undocumented immigrants (Valenzuela *et al.*, 2006), working mainly in construction, gardening, landscaping, painting, roofing, drywall installation, and moving and hauling (Rabito *et al.*, 2011; Valenzuela *et al.*, 2006). The majority of day laborers are Latino immigrants, with 59 percent of them originating from Mexico and 28 percent of them originating from other Central American countries (Valenzuela *et al.*, 2006).

Worker earnings, workers' compensation, and healthcare

Foreign-born white workers' median weekly earnings in 2011 were 105.5 percent of native-born white workers, foreign-born black workers' earnings were 99.5 percent of those of native-born black workers, and foreign-born Asian workers' earnings were 98.8 percent of their native-born counterparts (BLS, 2012b). In contrast, Latino immigrant workers earned only 77 percent of weekly earnings of their native-born counterparts (BLS, 2012b). Latino workers have the lowest median weekly earnings of all foreign-born workers. In 2011, their median weekly earnings were \$489 compared to \$868 for Asian foreign-born workers, \$614 for black foreign-born workers, and \$883 for white foreign-born workers (BLS, 2012b). Immigrant workers also have higher rates of poverty (Quesada *et al.*, 2011).

Particularly significant for Latino immigrant workers' income is their overrepresentation in temporary and contingent labor segments. Performing temporary and contingent labor is a

contributor to reduced income (McCauley, 2005). Contingent workers are more likely to have with lower household incomes than permanent workers (Cummings and Kreiss, 2008). Some categories of contingent workers, such as agricultural workers, are excluded from minimum wage and overtime protections (Cummings and Kreiss, 2008; Kawachi, 2008). Because an estimated 75 percent of day laborers are undocumented immigrants, they are particularly vulnerable to wage theft (Valenzuela *et al.*, 2006; Walter *et al.*, 2002). Results from the National Day Labor Survey demonstrated that nearly half of day laborers reported one or more incidents of wage theft during the past two months (Valenzuela *et al.*, 2006).

Among urban immigrant Latino workers, 56 percent had no workers' compensation coverage (Pransky *et al.*, 2002). Again, the nature of contingent and temporary work is a significant influence: many undocumented people seek temporary or contingent work, such as day labor, and are not covered by the workers' compensation system in case of injury on the job (McCauley, 2005; Passel and Cohn, 2012; Leclere and López, 2012). Temporary workers are less often covered by workers' compensation than permanent workers, and undocumented immigrant day laborers are vulnerable to refusal to pay workers' compensation claims (Cummings and Kreiss, 2008; Leclere and López, 2012; Valenzuela *et al.*, 2006; Walter *et al.*, 2002).

Immigrant workers have lower rates of health insurance coverage, which can make it difficult for those who get injured to receive adequate treatment (Quesada *et al.*, 2011). Foreign-born workers are less likely than native-born workers to have health insurance coverage, and Latinos in general are less likely than whites to have health insurance and lack of coverage rates are disproportionately higher among foreign-born Latinos (Vega *et al.*, 2009). In 2011, 33 percent of foreign-born workers lacked coverage, compared to 13.2 percent of native-born workers; more specifically, 48.1 percent of foreign-born Latinos lacked health insurance coverage, compared to 20.2 percent of native-born Latinos (US Census Bureau, 2012). Undocumented workers are susceptible to being deprived of healthcare coverage, as well as basic legal rights: among those who are undocumented, 59 percent lacked health insurance in 2007 (Quesada *et al.*, 2011; Passel and Cohn, 2012). In addition, most contingent workers lack health insurance (Leclere and López, 2012), with a mere 13 percent having employer-provided health insurance compared to 72 percent of non-contingent workers (Cummings and Kreiss, 2008).

Epidemiology of Latino immigrant workers' workplace injuries and fatalities

Many experts believe that official reports underestimate the prevalence of injuries due to the difficulty of assessing the number of workers and the frequency with which researchers identify workers who report injuries that were not reported to their employers (Brunette, 2004; National Research Council, 2003). Several studies have documented the problems with the occupational health surveillance system and indicated that there is much underreporting when it comes to health and safety problems of Latino immigrant workers (Azaroff *et al.*, 2002; Lowry *et al.*, 2010; Souza *et al.*, 2010). The Committee on Education and Labor (2008) reported that 69 percent of illnesses and injuries may go undocumented due to poor surveillance. There is also a lack of quality data sources which pertain to occupational health disparities based on race and ethnicity (Souza *et al.*, 2010). There are numerous reasons why Latino immigrant workers and their employers may not report work-related injuries and illnesses. Workers, especially those without documentation, may have an underlying fear of disciplinary action, denial of overtime or promotion opportunities, or even job loss as a result of informing their employer of an illness or injury (Azaroff *et al.*, 2002). Some workers could be uninformed or misinformed of their rights or may not perceive the connection between their injury/illness and their job, or they may not be able to afford the lost time from work (Azaroff *et al.*, 2002). Additionally, because Latino immigrant workers have lower rates of health insurance coverage, with a surge in numbers of workers lacking coverage in recent years, this could further deter them from seeking medical care for an injury or illness (McCollister *et al.*, 2010). From an administrative perspective, employers could fear increases to their health insurance premiums or may not have coverage for worker compensation (Azaroff *et al.*, 2002). While researchers have recently begun to use worker compensation data when examining occupational health disparities, these data do not include information on race, ethnicity, or a worker's place of birth (Souza *et al.*, 2010).

Injury rates and types of injuries at work

Among foreign-born workers, Latino immigrant workers bear a disproportionate burden of documented occupational injuries (Bureau of Labor Statistics (BLS), 2012a). Latino immigrant workers experience elevated rates of occupational injuries and fatalities compared to native-born workers (BLS, 2013a, b; Cierpich *et al.*, 2008; Vega *et al.*, 2009). In 2011, the overall non-fatal occupational injury incidence rate was 117.3 per 10,000 full-time workers, while occupations that involve limited physical exertion have injury rates that are lower than the national rate (BLS, 2012a). For example, management occupations had a rate of 43.5 injuries per 10,000 full-time workers, while architecture and engineering had a rate of 18.0 (BLS, 2012a). Incidence in farming, forestry, and fishing was 155.2 per 10,000 full-time workers, 201.3 in construction and extraction operations, 287.9 in building- and grounds-cleaning and maintenance, and 155.6 in production occupations (BLS, 2012a). In most years construction had the highest injury rates of all industries (Brunette, 2004).

Latino immigrant workers experience a number of injury-related consequences as the result of the work they perform. Types of injuries include traumatic injuries, falls, cuts, burns, and back injury, to name a few (Pransky *et al.*, 2002). Traumatic injuries such as getting caught in, under, or between workplace materials or machinery, falling from elevated heights, or slipping and falling are more prevalent among Latino workers due to working in risk-laden occupations; in particular, construction and manufacturing occupations experience traumatic injuries at greater rates when compared to other occupations (Smith *et al.*, 2010). These types of injuries have been considered some of the more costly occupational injuries within the construction sector and across all industries (Waehrer *et al.*, 2007). Falls were the second leading cause of non-fatal injuries in 2006 (Dong *et al.*, 2009). Falls from heights, when not fatal, are costly to injured workers, leading to an average of 44 lost work days (Gillen *et al.*, 1997). Acute traumas and heat illnesses have been attributed to the workplace in occupations frequently held by Latino immigrants. Workers in restaurant and food, cleaning, and manufacturing jobs have reported experiencing increased rates of burns (Hunt *et al.*, 2000; Walters, 2009), while workers in construction, agriculture, forestry, fishing, and manufacturing are injury-prone as a result of being struck by objects or vehicles (Islam *et al.*, 2001). Heat illnesses are most prevalent in construction, manufacturing, and agriculture as workers spend prolonged periods either outdoors in high temperatures or in confined spaces with limited temperature control (Bonauto *et al.*, 2007; Mirabelli *et al.*, 2010).

Studies have documented Latino immigrant workers' challenges with musculoskeletal disorders such as low-back pain, epicondylitis (arm pain similar to tennis elbow), and neck and upper-extremity disorders, all attributable to the workplace (Arcury *et al.*, 2014; Buchanan *et al.*, 2010; Douphrate *et al.*, 2014; Grzywacz *et al.*, 2012; Krause *et al.*, 2005; Premji and Krause, 2010; Quandt *et al.*, 2006; Rosenbaum *et al.*, 2013; Schulz *et al.*, 2013). Latino hotel-room cleaners and farmworkers had higher rates of musculoskeletal complications when compared to other occupations and the general population (Arcury *et al.*, 2014; Buchanan *et al.*, 2010; Douphrate *et al.*, 2014; Grzywacz *et al.*, 2012; Krause *et al.*, 2005; Premji and Krause, 2010; Quandt *et al.*, 2006; Rosenbaum *et al.*, 2013; Schulz *et al.*, 2013).

Latino immigrant workers are employed in construction or hotel cleaning occupations, which are associated with skin conditions or disorders, respiratory illnesses, cognitive and mental disorders, impaired fertility, increased risks of birth defects or other poor birth outcomes, and various forms of cancer (Hansen and Donohoe, 2003; Mills and Yang, 2007; Quandt *et al.*, 2013). Construction laborers experience elevated risks for hazardous noise exposure that could lead to hearing complications (Tak *et al.*, 2009). In a study of Latino day laborers, participants exhibited prevalent symptoms, with 51 percent reporting respiratory symptoms, 45 percent headaches, 44 percent sinonasal symptoms, 25 percent throat symptoms, 30 percent eye symptoms, and 14 percent skin symptoms (Rabito *et al.*, 2011).

When compared to other immigrant populations, Latinos have the highest prevalence of overweight, obesity, and diabetes and exhibit a higher incidence of unhealthful behaviors, cardiovascular disease, and cancer (in particular, cervical, liver, and stomach cancers) (Oza-Frank and Narayan, 2010; Burgard and Lin, 2013; Clougherty *et al.*, 2010; Landsbergis *et al.*, 2014; Ayala *et al.*, 2008; Vega *et al.*, 2009). Consequently, Latino workers have time-delayed repercussions of worsened health and a resultant decreased quality of life in the later years

(Haas *et al.*, 2012). In addition to the physical tolls Latino immigrants experience as the result of their work, they also experience increased risk for psychological disorders, such as depression and anxiety rooted in work-related stress (Landsbergis, 2010).

Contributors to injuries at work

Individual characteristics of Latino immigrant workers have been associated with workplace injuries. Language-based communication skills are critical, as foreign-born workers with limited English speaking ability are more likely to work in riskier jobs and subsequently encounter higher risks for occupational injury and fatality (Orrenius and Zavodny, 2009). Lower educational attainment of Latino immigrant workers may partially account for occupational health disparities, as increased risks for injury and fatality among workers are associated with lower levels of educational attainment (BLS, 2013a, b; Orrenius and Zavodny, 2009). Also, the relatively young age of Latino immigrant workers appears to be related to occupational injury rates, as the reported average age of injured Hispanic workers was 35, compared to 40 and 42 among whites and African-Americans, respectively (Forst *et al.*, 2010).

Temporary or contingent work is also associated with workplace injuries. Performing temporary and contingent labor is a contributor to higher rates of injury (McCauley, 2005). Research on the health of contingent workers has demonstrated higher rates of work-related injuries compared to permanent employees (Benavides *et al.*, 2006; Cummings and Kreiss, 2008; Kivimaki *et al.*, 2003; Seixas *et al.*, 2008). A national survey of day laborers found that 19 percent reported occupational injuries that required medical attention (Valenzuela *et al.*, 2006), while a survey of day laborers in Seattle, Washington recorded an injury rate of 31 per 100 full-time employees (Seixas *et al.*, 2008). Contingent workers are more likely to be willing to engage in risk-laden job tasks and are less likely to refuse to perform tasks they believe to be hazardous due to fear of losing their employment and income (Lowry *et al.*, 2010). Performing temporary and contingent labor is a contributor to increased exposure to hazards (McCauley, 2005). Temporary work has been shown to proliferate risks of musculoskeletal pain (Smith *et al.*, 2010). Another study reported that 58 percent of day laborers experience high levels of stress (Duke *et al.*, 2010).

Types of occupations held by Latino immigrants has also been shown to influence the occurrence of workplace injuries. Numerous workers perform repetitive motions and bend and work in awkward positions with limited training in ergonomic positioning, and traumatic injuries occur when a substance is spilled on the floor, machinery malfunctions, or when proper safety training leads to improper use of equipment. Farmworkers are frequently placed in dangerous situations or in hazardous conditions that are unwarranted and are a result of improper equipment or materials, negligence on the part of employers, or lack of enforcement of governmental safety and health regulations, and much has been depicted pertaining to farmworkers' exposure to pesticides and other chemical substances used on agricultural fields (Hansen and Donohoe, 2003; Kasner *et al.*, 2012; Quandt *et al.*, 2013). Construction workers are exposed to hazards that are common in construction worksites, including noise; exposure to cement, asbestos, lead, carbon monoxide, and other harmful substances and materials; machinery; and working on scaffolding or other elevated surfaces (Dong and Platner, 2004; Tak *et al.*, 2009). Latino immigrant workers who are employed in construction or hotel cleaning positions are also susceptible to exposures to toxic materials as a result of physical contact, inhaling, ingesting, ocular penetration, or through elevated noise levels from equipment; further, hotel workers are routinely placed at risk due to the chemicals used in cleaning products that they use as part of their work (Hsieh *et al.*, 2013). Workers in manufacturing are exposed to hazardous materials, particularly when working in enclosed spaces such as in factories with sweatshop conditions which do not meet the required standards of the industry (Smith *et al.*, 2010).

Numerous psychosocial issues endemic to Latino immigrant workers further contribute to workplace injuries. These workers face challenges with acclimating to a new culture, especially when they have left family members behind in their native lands, presenting a challenge for their mental well-being as a result of entering the new workplace (Grzywacz *et al.*, 2006, 2010). Oftentimes, due to work environments with high demands and limited control over working conditions, Latino immigrants experience numerous work stressors that place them at increased

risk for psychological disorders (Landsbergis, 2010). Studies of Latino farmworkers have revealed that as the pace of work or workload increases, their subsequent depressive (Crain *et al.*, 2012; Grzywacz *et al.*, 2010) and anxiety (Crain *et al.*, 2012) symptoms intensify, and that farmworkers experience a decline in cognitive abilities (Nguyen *et al.*, 2012). Many Latino immigrants also encounter discrimination, inconsistency in the nature of work, financial challenges, and a fear of wage theft, which exacerbate the stressful conditions at the workplace (Negi, 2011). As evidenced across the US workforce, job insecurity and temporary employment, commonly linked with mental illnesses, are currently at elevated levels, and Latinos consistently experience increased rates when compared to other workers (Landsbergis *et al.*, 2014). The poor mental well-being experienced among Latino immigrant workers has also led to many turning to harmful substances as a coping mechanism, and poor mental health is a contributor to the increased musculoskeletal injuries of Latino immigrant workers (Negi, 2011; Grzywacz *et al.*, 2010).

Lastly, Latino immigrant workers are susceptible to social and economic inequalities, both in and out of the workplace, which are foremost determinants of their increased chronic disease risks (Vega *et al.*, 2009). Given that occupation is the primary determinant of income potential, health-promoting resources, healthcare access, living conditions, and social status, the conditions experienced by most Latino immigrants serve as a trigger for poor health. Structural inequalities (i.e. low wages, job insecurity and poor working conditions, lack of healthcare access and workers' compensation, lack of access to government-funded social services, food insecurity) due to political, social, and cultural forces, and the resultant poverty-stricken standards of living that are often experienced by Latino immigrant workers pose increased disease risk in the form of obesity and associated comorbidities when compared to native-born workers (Johnson, 2010; Lieber, 2008). Furthermore, Latino immigrants experience economic constraints as well as difficulties in acculturation and adoption of new social norms, which in turn have serious effects on their health-related behaviors (Ayala *et al.*, 2008; Vega *et al.*, 2009). Cumulatively, the recurring job stressors and substandard living conditions of Latinos have time-delayed repercussions of worsened health and a resultant decreased quality of life in the later years (Haas *et al.*, 2012).

Fatality rates and types of fatalities at work

Occupational fatality rates are higher among Latino workers compared to all workers (Byler, 2013; Cierpich *et al.*, 2008). From 1992 to 2006, the annual work-related fatality rate was higher among Latinos than all US workers for every year except 1995. In 2006, Latino workers had a work-related death rate of 5.0 per 100,000 workers compared to 4.0 for all US workers. Foreign-born Latino workers have higher fatality rates than their US-born Latino peers. From 2003 to 2006, the work-related fatality rate among foreign-born Latinos was 5.9 per 100,000 workers compared to 3.5 for US-born Latino workers (Cierpich *et al.*, 2008). Across all occupations from 1992 to 2006, the most common fatal events among Latino workers included homicide (1992-1996), highway incidents (1997-1999, 2001-2005), and falls to a lower level (2000, 2006) (Cierpich *et al.*, 2008). From 1992 to 2006, the prevalence of work-related homicide among Latino workers decreased by 37 percent while falls to a lower level increased by 370 percent over the same period (Cierpich *et al.*, 2008). Overall, falls were noted as the leading cause of fatal injuries in 2006 (Dong *et al.*, 2009). Latino workers have 1.54 odds of a fatal fall (95 percent CI 1.38-1.72) compared to their Non-Hispanic counterparts and nearly 80 percent of Hispanic decedents from 2003 to 2006 were foreign born (Dong *et al.*, 2009). Among Latino workers, foreign-born workers have significantly higher odds of fatal falls (OR 1.36, 95 percent CI 1.08-1.67) than US-born Latino workers.

The industries that had the highest fatality rates among Latino workers from 2003 to 2006 were construction, administrative and waste services, agriculture/forestry/fishing/hunting, and transportation/warehousing (Cierpich *et al.*, 2008). Construction and manufacturing occupations experience fatalities at greater rates when compared to other occupations, and in most years construction had the highest fatality rates of all industries (Brunette, 2004; Smith *et al.*, 2010). During 2003-2007, the fatality rate for grounds-maintenance workers (36 percent of whom were Latinos) was 13.3 per 100,000 compared to a rate of four per 100,000 US workers overall

(Centers for Disease Control and Prevention (CDC), 2011). Surveillance data revealed that 31 percent of fatalities among grounds-maintenance workers from 2003 to 2008 were of Latino workers and 83 percent of those were foreign born (CDC, 2011).

Contributors to fatalities at work

Events leading to fatalities include transportation incidents (31 percent), contact with objects and equipment (25 percent), falls (23 percent), and traumatic acute exposures to harmful substances or environments (16 percent). When Latino construction workers were asked why Latino workers have higher fatality rates than whites, they reported that Latinos experience pressure from supervisors to work faster and for longer hours than their white coworkers (Roelofs *et al.*, 2011). The same workers also reported that they rarely received safety training and that they were frequently required to work either with defective protective equipment or none at all (Roelofs *et al.*, 2011). These workers did not feel they were able to demand a better safety climate due to an “atmosphere of intimidation” in which workers were reminded that competition for jobs is steep and they were replaceable (Roelofs *et al.*, 2011). Longevity of work arrangements appears to play a factor in fatality rates: performing temporary and contingent labor is a contributor to higher rates of fatality, and the majority of fatal falls among workers under age 35 occurred in workers who had been employed for less than a year (McCauley, 2005; Dong *et al.*, 2009). Another factor seems to be the size of employer, as fatal falls occur at a disproportionate rate among workers in small companies with ten or fewer workers, with nearly two thirds of fatal falls occurring in small companies, despite only 30 percent of construction workers being employed in smaller companies (Dong *et al.*, 2009).

Prevention

Interventions to reduce occupational health and safety hazards of Latino immigrant workers are sparse. There exists an urgent need for prevention programs in both industries as the proportion of workers who are Latino continues to grow, and the focus on the prevention of injuries and illnesses among these workers becomes more imperative. For example, Latinos represent 18 and 37 percent of the labor force in construction and agriculture, respectively (Brunette, 2004); however, limited interventions have primarily focussed on these two occupational categories. The most common workplace-focussed interventions have centered on four areas: interventions focussed on safety training, interventions that are individual based, and interventions tailored for Latino immigrant workers.

Safety training

Most intervention research that is aimed at Latino immigrant workers focusses on safety training. Many Latino immigrant workers are not provided safety training despite their constant exposure to a number of hazards on the job: for example, of those Latino immigrant workers employed mainly in construction, maintenance, hospitality and landscaping in Alexandria, Virginia, only 31 percent reported receiving job-safety training (Pransky *et al.*, 2002), and among Mexican immigrants in New York City employed in restaurants, cleaning, and construction, only 22 percent reported receiving safety training (Gany *et al.*, 2011). Extant research demonstrates that there is an urgent need for improved safety training as a whole, especially in construction; however, little research has evaluated such programs and even less research has focussed on training designed specifically for Latino construction workers (Dong and Platner, 2004). Temporary and contingent work arrangements in particular are associated with poorer training safety climate, and undocumented immigrant day laborers are particularly vulnerable to failure to provide safety equipment and training (Cummings and Kreiss, 2008; Rabito *et al.*, 2011; Valenzuela *et al.*, 2006; Walter *et al.*, 2002). Implementation of safety training for Latino immigrant workers presents unique challenges: a National Institute for Occupational Safety and Health investigation into 200 deaths of Latino workers from 1992 to 2006 demonstrated that characteristics related to the increased fatality rates among Latino workers included “inadequate knowledge and control of recognized safety hazards and inadequate training and supervision of workers, often exacerbated by different languages and literacy levels of workers”

(Cierpich *et al.*, 2008). Hence, much of the challenge with educating Latino workers is linked to language barriers and a general lack of awareness of safety precautions and overcoming language barriers and cultural differences (Arcury *et al.*, 2010).

Individual-based interventions

While limited, the focus of individual-based interventions has been primarily on farmworkers. Interventions conducted around preventing injuries and illnesses of Latino farmworkers, much like with construction workers, have predominantly centered on individual-level strategies of enhancing knowledge and changing attitudes toward the use of protection at worksites. For example, when examining the tools that farmworkers use, it was found that many of the musculoskeletal pains they experienced were the result of incorrect positioning and improper body posture attributable to the inadequacy of the equipment (Earle-Richardson *et al.*, 2005; May *et al.*, 2012). As a result, in one case farmworkers were fitted for waist belted bins to properly handle large collections of apples (Earle-Richardson *et al.*, 2005), while in another case it was discovered that blueberry harvesters should be using a long-handled rake as opposed to the short handle to help prevent back pain (May *et al.*, 2012).

Tailored interventions

Some researchers have generated moderate success by tailoring their interventions to meet the specific needs of Latino construction workers (Forst *et al.*, 2013; Menzel and Shrestha, 2012; Williams *et al.*, 2010). By working in a community-based participatory manner with Latino construction laborers, training and education materials have led to increases in the knowledge and attitudes around the importance of using protective equipment and in providing safety mechanisms for coworkers (Forst *et al.*, 2013; Williams *et al.*, 2010). Results of another intervention revealed that not only had knowledge been enhanced, but that Latino workers were nearly two times more likely to use the knowledge to prevent injuries when compared to non-Latino participants after receiving training (Menzel and Shrestha, 2012). One particular intervention that used community health workers to help overcome linguistic and cultural barriers focussed on eye protection of farmworkers and found that by both providing safety glasses and educating the workers on the importance of wearing them, the likelihood of their use increased (Forst *et al.*, 2004). The La Familia program for farmworkers and their families in North Carolina, through the use of lay health advisors, has helped to raise awareness of behaviors that can help to reduce exposures to pesticides (Arcury *et al.*, 2009). Another study also reported that knowledge enhancement, through the use of language-tailored tactics, led to changes in the likelihood of practicing behaviors to prevent or reduce pesticide exposure (Acosta *et al.*, 2005). While beneficial in the short term, these types of programs fail to address the underlying causes of injury risks, which are out of workers' control – thus making imperative the introduction of macro-level interventions in complementing ongoing behavioral approaches (Arcury *et al.*, 2009).

Safety policy/legislation

Researchers recognize that increased safety training and individual-focussed interventions are not a panacea as many of the issues are out of the control of workers. Many have called for improved enforcement of safety legislation with targeted inspections of smaller establishments as an important policy-level intervention that is more than necessary (Dong *et al.*, 2009; Okun *et al.*, 2001; Rivara and Thompson, 2000). For example, there are very few legislative requirements for health and safety training in agriculture (Arcury *et al.*, 2010), and as a result little takes place. At a macro-level, governmental policies and standards issued by the Occupational Safety and Health Administration have systematically been incorporated to protect workers but oftentimes fail to limit risks, as either employers do not abide by the regulations and/or they are not properly enforced by governmental agencies responsible for monitoring and holding employers accountable (Liebman *et al.*, 2013). As more research is performed with Latino immigrant workers, particularly with more influence from various stakeholders and the workers and community-academic partnerships, perhaps stricter enforcement can occur (Liebman and Augustave, 2010).

Introducing an integrative systems-based paradigm

Causal factors that contribute to the excessive workplace injury and fatality burden experienced by Latino immigrant workers are complex. Individual, cultural, occupational, and policy factors all contribute to health disparities of these workers and present significant and unique challenges in improving their physical and psychological well-being. Due to the limitations of existing approaches to mitigate excessive workplace injury and fatality burdens among Latino immigrant workers, there is an urgent need for interventions that aim to change components and conditions of the workplace and address institutional and structural factors within the broad work environment that are related to or induce illness, injury, and inequities. Foregoing data clearly indicate that Latino immigrant workers' excess health and safety problems operate as a complex system characterized by reciprocal relationships among diverse actors, including the workers themselves, their employers, and policymakers. Despite this, existing research has adhered to simplistic and oftentimes false dichotomies in conceptualizations of important factors (i.e. individual- and population-level factors, social and behavioral factors) that have influenced both methodological and analytical strategies in understanding disproportionate health and safety outcomes and in devising preventive programs. Grounded heavily in individual-focussed theories, unidirectional or incomplete biomedical and behavioral conceptual frameworks, risk-factor designs, and overall reductionist methodologies, research on Latino immigrant worker health disparities has mostly dissected out proximal and medial safety-related factors of this complex and dynamic system and analyzed them in isolation. This research has focussed on the symptoms (i.e. chronic pesticide exposure) of interacting, health-compromising work and sociocultural contexts that are only the causal risk factors that affect worker health (i.e. ovarian cancer) rather than on those structural factors that induce and exacerbate a plethora of disproportionate comorbidities. While controlling for these proximal and medial factors (i.e. in the form of low-leverage interventions such as individual-based training programs) is imperative for reducing risks for a number of vulnerable workers at a specific point in time, is not sufficient to improve sustainably the safety and health of workers at excess risk as they fail to address the underlying sources of these chronic and complex problems. While interacting living and working conditions shape immigrant workers' overall safety and health – as they directly affect their actual health-related behaviors in the worksite as well as resultant and interacting physiopathological changes and psychosocial responses – it is structural factors such as national and state social and labor policies, corporate regulations, and their enforcement that determine the quality, standards, and conditions of the workplace.

Grounded in these principles, prevalent epidemiological and intervention models in research focussing on Latino immigrant worker health disparities are based on reductionist, individual-focussed, depoliticized conceptualizations and methodologies that neglect the importance of political economy and public policy, and are designed to apply linear statistics to understand proportional relations among variables assuming unidirectional causality. This narrow focus on causation has subsequently neglected all those structural factors that induce or regulate the proximal and medial causal factors that directly cause disease and generate disparities. The conceptual models and analytical tools that have been used have not and cannot take into account the interrelationships, reciprocity, and the frequently discontinuous nature of connections that underlie health and safety risks of Latino immigrant workers, nor can they fully recognize pathways linking their various levels. Extant methodologies and analytical tools cannot handle feedback loops because even sophisticated techniques (i.e. latent class analysis) can break down in the presence of such loops, threshold effects, tipping, and other types of nonlinearity (Galea *et al.*, 2010). Reductionist methods are not designed to put all pieces together to yield the much needed big picture. This inaccurate conceptualization and inappropriate analytical tools might also be an explanation for the modest proportion of explained variance achieved by traditional prevention research (Resnicow and Page, 2008) as well as unsatisfactory intervention results (Glass and McAtee, 2006).

To more efficiently delineate Latino immigrant worker health disparities and more effectively intervene with high-leverage policies, we need new ways of thinking, new explanatory frameworks, and new analytical approaches and tools that match the complexity of the problem at hand (instead of matching our research questions to commonly used methodologies and

analytical techniques). Given the compartmentalized design of reductionist approaches, the complex systems paradigm reframes Latino immigrant worker health problems by changing the unit of analysis from the “broken” isolated parts of a closed system to an open system as a whole. This transition not only requires a fundamental mind shift but, most importantly, it needs major investments in theory, methods, policy, and practice. Although complexity science in occupational health disparities research is in its infancy, it does provide the conceptual frameworks and the analytical techniques that can help unify and complement useful parts of other conceptual and methodological approaches (Diez Roux, 2011).

Systems (or complexity) science rests on: first, dynamic and complex systems that arise from an intricate interplay of multiple, multilevel, diverse, and evolving factors over time and across settings and contexts; second, nonlinearity involving reciprocal interactions among densely connected, oftentimes overlapping, and recursive feedback loops that are circular couplings of events that link, release, and link again from outside and from within the system; third, systems that are sensitively dependent on initial conditions as changes to the system often do not lead to proportional results – or the “butterfly effect” referring to small changes oftentimes leading to disproportionately larger effects later on; and fourth, systems that are self-organized without hierarchy and exhibit adaptation that allows them to modify their structure to cope with environmental influences involving continuous and discontinuous changes and unpredictable outcomes (emergent properties) (Zimmerman *et al.*, 2001).

Predicated on these key assumptions: first, systems thinking can promote the development of more sophisticated dynamic conceptual models of the determinants of Latino immigrant occupational health disparities; second, systems methodologies and analytical tools can assist in the exploration and refinement of these models and evaluate the effects of different interventions in the context of dynamic relations; and third, the use of systems science approaches can enhance the use of existing data and promote the collection of additional new types of needed data (Diez Roux, 2011). Systems-based analytical tools center on various forms of statistical, mathematical, and computer-based modeling and simulation such as agent-based modeling, system dynamics modeling, dynamic microsimulation, and so forth. Computational and simulation modeling techniques represent a much promising avenue to address the systemic complexities of immigrant worker safety and health disparities.

Conclusion

Although estimating Latino workers’ occupational characteristics is difficult due to inadequate surveillance systems and underreporting of illnesses, injuries, and fatalities, it is apparent that these workers experience overall excess safety and health morbidity, disability, and mortality when compared to native-born workers. While we recognize the importance of the needs of the community and that these improvements will not occur without the community members being actively involved, we focussed on the broad issues at various levels impacting the health outcomes of this working population. We tried to include in our results examples of the use of lay health advisors and the tailoring within interventions (audience, language, etc.) and the importance of gaining trust from key community members. Concerning the importance of integrated system approaches, we believe that improving the health of Latino immigrant workers will require collaboration from a wide range of professional disciplines (employers, government institutions, national institutions, etc.) and this will ultimately require working closely and listening to the needs of those affected. Future research should include gathering qualitative data from this population to further explore the structural factors impeding the improved health both within and outside of the workplace. Such data can be integral in generating interventions to meet the needs and in improving current policies impacting the population.

Despite prevalent reductionist epistemologies and methodologies, and individual-based conceptualizations and explanations based on education and training, the actual causes of these excess health outcomes, as well as disparities, are linked with inadequate public policy frameworks and are exacerbated by immigration status, cultural differences, and linguistic barriers of immigrant workers. Systems-based methodologies and analytical approaches, coupled by a strong emphasis in public policy, have the potential to improve our understanding of these disparities and inform high-leverage interventions.

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