Review

Expanding the Focus of Occupational Safety and Health: Lessons from a Series of Linked Scientific Meetings

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Abstract: There is widespread recognition that the world of work is changing, and agreement is growing that the occupational safety and health (OSH) field must change to contribute to the protection of workers now and in the future. Discourse on the evolution of OSH has been active for many decades, but formalized support of an expanded focus for OSH has greatly increased over the past 20 years. Development of approaches such as the National Institute for Occupational Safety and Health (NIOSH)'s Total Worker Health® concept and the World Health Organization (WHO)'s Healthy Workplace Framework are concrete examples of how OSH can incorporate a new focus with a wider view. In 2019, NIOSH initiated a multi-year effort to explore an expanded focus for OSH. This paper is a report on the outputs of a three-year cooperative agreement between NIOSH and The University of Texas School of Public Health, which led to subject matter expert workshops in 2020 and an international conference of global interest groups in 2021. This article traces the background of these meetings and identifies and assesses the lessons learned. It also reviews ten thematic topics that emerged from the meetings: worker health inequalities; training new OSH professionals; future OSH research and practice; tools to measure well-being of workers; psychosocial hazards and adverse mental health effects; skilling, upskilling and improving job quality; socioeconomic influences; climate change; COVID-19 pandemic influences; and strategic foresight. Cross-cutting these themes is the need for systems and transdisciplinary thinking and operationalization of the concept of well-being to prepare the OSH field for the work of the future.

Keywords: expanding occupational safety and health paradigm; future of work; occupational safety and health; transdisciplinary; inequality; training and education; research methods; psychosocial; mental health; well-being; socioeconomic; climate; pandemic; strategic foresight

1. Introduction

The nature of work, the workforce and the workplace have changed and will change even more in coming years [1–7]. These changes will be profound, broadly impacting the world of work and creating new hazards and outcomes (Table 1). The predominant expected trend will be toward more adverse psychosocial effects of work, although some long-known chemical, physical, biological, and ergonomic hazards will persist and new ones may emerge [3,8–10]. Mental health problems such as depression, burnout, anxiety, and fatigue are already increasing rapidly and are expected to continue to grow, as will their costs to the global economy [11–16]. Along with demographic, social, and political changes,

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the impact of technology, climate change and globalization will also be significant [5]. In many ways, the COVID-19 pandemic has accelerated some of these trends and is likely to change work in the future, as will other pandemics [17].

Table 1. The world of work is changing.

Work	Workforce	Workplace
Mosaic of old and new hazards Shift from physical to mental work More service work Work intensification Many jobs in a working lifetime Emotional labor	Greater distribution of older workers More immigrants More women Less unionization Increased chronic disease burden	New work arrangements More telecommuting Contractors and temporary workers More small businesses Decrease in social protection Pandemics Increased climate-related hazards

The complex future interactions of how workers will be employed and the jobs they will perform will give rise to a broad range of new hazards, necessitating the occupational safety and health (OSH) field to expand its focus and evolve strategies that both protect workers and support enterprise productivity [1–3]. This overview of the world of work and proposal for an expanded focus for OSH was presented in a previous study, which is described below [18] and serves as the foundation for the current article and the cooperative agreement described herein.

Schulte et al. [18] proposed the expanded focus model presented in Figure 1 [18,19]. The model includes expansion in two directions: (1) horizontally, to include not only traditional OSH but also consideration of personal, social, and economic risk factors and (2) vertically, to foster a view of the entire working life and the use of an overarching concept of well-being to encompass the complexities of the changing world of work.
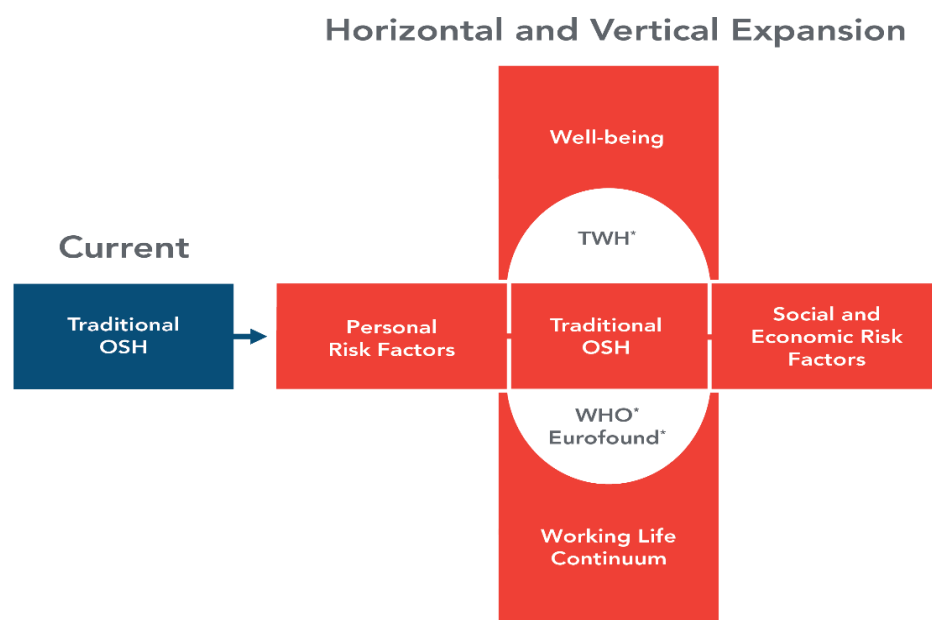
Figure 1. Model for an expanded focus for the occupational safety and health field [18,19].

Calls for the OSH field to evolve are not new. A broad range of literature identifies the need and direction for OSH evolution (Table S1 and Figures S1–S4 in the Supplementary Materials) [2,3,7–10,18–113]. This history of an expanded focus for OSH, which is discussed in the Supplementary Materials, draws on literature that anticipates how OSH will be practiced in a future that is quite different from the past; involves conceptual, psychological, technical, and ethical expansions; and addresses only the modern eras (after 1970). Overall,

the literature anticipates how future OSH will be practiced in a world of work quite different from the past. Novel skills, competencies, scope, research, and practice will be needed. Regardless of these changes, employer responsibility to provide safe and healthy work and governments to set limits remains a constant. The cooperative agreement described in this paper brought forth *Expanding Occupational Safety and Health: An International Conference* (Ex4OSH conference) and two subject matter expert workshops addressed themes that will pervade the future of OSH.

2. Materials and Methods

This article builds on a horizon scan of the literature (Figures S1–S4 in the Supplementary Materials) to analyze the outputs of two 2020 subject matter expert workshops and a broad 2021 stakeholder-based international conference (Ex4OSH) (Figure 2) [18,19,76,114] (go.uth.edu/EX4OSH). These meetings were a product of a 2019 3-year cooperative agreement, entitled *Shaping the future to ensure worker health and well-being: shifting paradigms for research, training, and policy*, between the National Institute for Occupational Safety and Health (NIOSH) and The University of Texas Health Science Center at Houston School of Public Health, Southwest Center for Occupational and Environmental Health [114]. The cooperative agreement application was supported by a broad range of interest groups from labor, business, academia, and government.
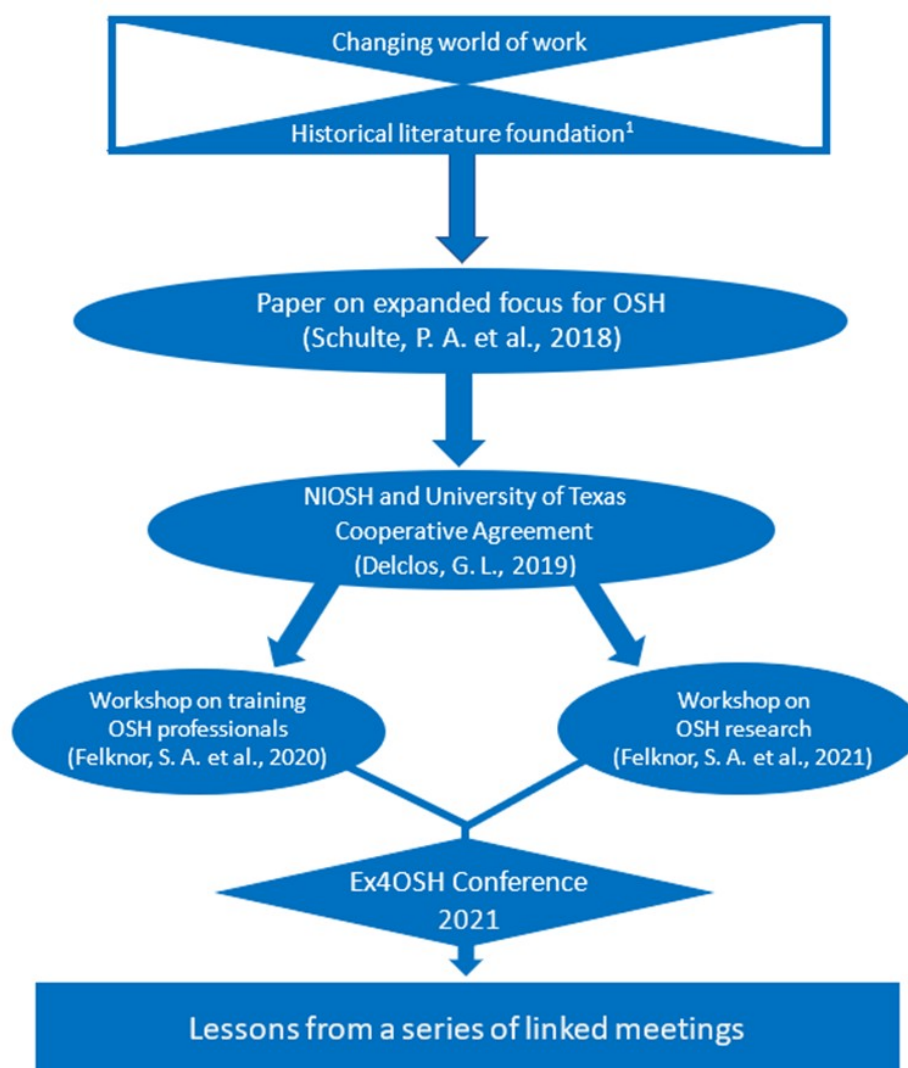
Figure 2. Overview of literature assessment and scientific meetings [18,19,76,114] ([1] See Table S1 in Supplementary Materials for historical literature foundation).

The section below synthesizes the key themes, recommendations, and next steps from all three meetings. The recommendations from the two preliminary workshops were developed by a group consensus process. These outputs were then used in the planning of the Ex4OSH conference. The authors of this article drew on the Ex4OSH outputs and presentations to identify emergent themes and make observations and recommendations that might be useful in guiding the field in the future.

3. Significant Emergent Themes from the Workshops and Ex4OSH Conference

Worker well-being and the need for OSH to expand and evolve were the central themes of all three meetings, which also considered how this should drive changes in approaches to training, research, and policymaking. OSH should position itself to lead efforts to prevent workplace hazards, keep workers safe and contribute to overall worker well-being [80,115–117]. The problems of current and future work—including precariousness, lack of meaning, unhealthy organizational conditions, low wages, non-standard work arrangements, changing workforce demographics, skills mismatch and deficiency, powerlessness, overload, and others—require the application of a broad overlying concept of well-being, which implies a more holistic approach to the status of workers in terms of health, satisfaction, and flourishing [5,7,118,119]. For well-being to be more than a conceptual goal, it should be operationalized [48,63,119] (see Section 3.4, on tools). Several approaches to operationalizing well-being have been launched, including the Centers for Disease Control and Prevention (CDC)/NIOSH Total Worker Health® approach [74] and the International Labour Organization (ILO) focus on decent work [75], which is one of the 2030 sustainable development goals (SDG-8). Decent work "involves opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in decisions that affect their lives and equality of opportunity and treatment for all women and men" [75]. Both work and non-work factors reciprocally affect the health and well-being of workers [120]. Risk factors in the workplace can affect or be affected by other factors long considered as non-work-related [121–123]. For example, data were presented at Ex4OSH that obesity, cigarette smoking, cardiovascular disease, mental health conditions and many other outcomes were strongly related to work conditions, particularly "iso-strain" (constant strain), which is related to low-control and high-demand types of work [89,124–128]. Extensive data show that workers are suffering from stress, depression, anxiety, burnout, and other adverse mental health effects [90,118,129,130]. These outcomes should be studied over a working lifetime to fully capture their magnitude, impact, and responsible factors [27,131].

To address current and future well-being and the hazards and risks that workers face, today's paradigm must shift from the biomedical model to the more expansive biopsychosocial model [59,86,132–134]. The biomedical model served OSH well but is limited and reductionist, addressing hazards one at a time, in part because of regulatory and structural drivers. That approach will not suffice in the current or future work environment, where more complex issues of change management, job quality, stress, equity and worsening mental health among workers are pertinent.

Refocusing on well-being and decent work under a biopsychosocial model has many implications for OSH: training professionals, conducting research, and developing policy directions and dimensions; and growing the field. In the wake of the COVID-19 pandemic, the changes in the world of work are accelerating, highlighting the urgency to keep pace by similarly evolving worker health, safety, and well-being efforts [77]. The following subsections focus on ten emergent themes from the conference and workshops: worker inequalities; training new OSH professionals; future OSH research and practice; tools to measure well-being of workers; psychosocial hazards and adverse mental health effects; skilling, upskilling and improving job quality; socioeconomic influences; climate change; influence of the COVID pandemic on OSH; and strategic foresight. A summary of key issues and recommendations for each theme is included in Table 2.

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Table 2. Summary of Key Issues and Recommendations for Identified Themes from the Ex4OSH conference [1].

Theme	Key Issues	Recommendations
Worker health inequalities	• Influence of a job goes beyond working conditions to circumscribing workers' lives • Disproportionate burden on essential workers from COVID-19 • Growing disparities from resources going to capital vs. labor investments	• Explore how structural disadvantages influence worker health • Use a biopsychosocial model to focus research and address inequalities
Training new OSH professionals	• Need to reorient OSH professional training to be mindful of the future of work	• Take a more holistic approach to OSH that proactively anticipates hazards • Utilize system science and transdisciplinary approaches
Future of OSH research and practice	• OSH researchers will face new challenges that will need investigation • Enhanced practices of OSH to address decent work and well-being will face important obstacles	• Identify pertinent affected partners to participate in research discussions • Consider a broad range of social, economic, political, and cultural factors in OSH research and practice
Tools to measure well-being of workers	• Thriving from work Questionnaire • NIOSH Well BQ questionnaire	• Operationalize well-being
Psychosocial hazards and adverse mental health effects	• Increased prevalence and incidence of adverse mental health effects from work • New psychosocial hazards to work • Trends exacerbated by COVID-19 • The need for psychosocial safety climate	• Develop and implement guidance for assessing and preventing work-related psychosocial hazards
Skilling, upskilling and improving job quality	• Technological displacement of workers • Skill-related issues for white- and blue-collar workers • Utility of union construction approach	• Standard approaches to job quality can be enhanced by using an industry of sector strategy
Socioeconomic influences	• A variety of socioeconomic factors will influence future occupational hazards	• Development and enforcement of stricter socioeconomic policies • Agreement between employers and trade unions on work organization
Climate change	• Biggest global threat of 21st century • Workers are among the first to be adversely affected • Seven categories of climate-related hazards	• Include climate-related knowledge in OSH curricula
COVID-19 pandemic influences on OSH	• Workers have been significantly affected by the COVID-19 pandemic • Pandemic accelerated decline of well-being • More awareness of psychosocial hazards • Pandemic illustrated the utility of Total Worker Health	• Strengthen the link between occupational health and public health • Learn how to address the OSH effects of pandemics and sudden disruptions in timely and innovative ways

[1] Recommendations from the Ex4OSH conference are based on guidance from the speakers and authors rather than consensus. Recommendations from the two pre-conference workshops are published elsewhere [19,76].

3.1. Worker Health Inequalities

As noted in the Ex4OSH opening address by the U.S. Secretary of Labor, Marty Walsh, a safe and healthy workplace should never be the privilege of a few, and it is every worker's right to return home safe and sound at the end of a work shift [135]. The COVID-19 pandemic represents an opportunity to underscore the need to make broad strides in OSH to address worker health inequalities [17]. For example, during the pandemic, not all workers were able to transition to work from home or remotely. The health impacts fell dispropor-

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tionately on essential workers and their families, and the economic impacts fell heavily on low-wage workers, women, racial minorities, and immigrants [136–138]. There was clear proof that workforce disparities are unjust and unsustainable [136]. However, even before the pandemic, growing disparities between the amount of resource going to capital and the amount going to labor were widely acknowledged [139]. From 1980 to 2019, annualized earnings growth in the United States averaged approximately 1% for a vast number of workers [135]. In contrast, those at or above the 95th percentile of income distribution saw their annual earnings growth increase rapidly, from 1.5% to 6% [60,135,140–142]. This earnings inequality is driven in part by organizational restructuring, the fissured workplace and increasing inequality between companies [143].

While work has long been acknowledged as a social determinant of health, the assessment of its role has generally been limited to models of workplace physical, chemical, ergonomic, and safety exposures [85,144,145]. However, the influence a job has on health goes well beyond specific physical working conditions, circumscribing workers' lives and those of their families. Jobs determine how much money a worker has, the neighborhood they live in, the schools their children attend, as well as their community and political participation [145–147]. Emotionally, a job influences self-esteem and stress. Socially, a job impacts other factors such as status, connectedness, free time, and peer interactions and supports. In short, work is not only a social determinant of health in and of itself; it also significantly impacts and is impacted by other social determinants of health and well-being [85,86]. Nonetheless, it remains largely absent in health inequalities research [116,145], as do the roles of unemployment and underemployment [81].

Clearly, the distribution of work-related benefits and risks is a result of how society is structured along social axes (race/ethnicity, class, gender, nativity, etc.), how business is structured (competitive bidding, business size, subcontracting practices) and how jobs are structured (employment arrangements, shiftwork, autonomy, precarious work) [145]. The field of OSH needs to understand how structural disadvantages materialize and influence worker health [145]. The use of biopsychosocial model–focused research will be critical in this regard [145].

3.2. Training New OSH Professionals

The need to reorient OSH professional training with the future of work in mind was the main theme of the first preparatory workshop (February 2020) and a major focus of the Ex4OSH conference [76]. There was broad agreement that future OSH professionals should take a more holistic approach and be proactive in anticipating hazards in the future of work. Preparation will involve training in systems science and transdisciplinary approaches. Systems science involves understanding the interconnections of elements (systems) that are organized to achieve a specific purpose [76,148,149]. These methodologies are "thought to enable researchers and decision-makers to examine system components and the dynamic relationships between them at multiple levels from cell to society" [149]. A transdisciplinary approach is an " . . . integrative process that synthesizes and extends disciplinary-specific theories, concepts, or methods to create new models and language to address OSH issues [18]." These methods cross multiple disciplines and professions, resulting in a broader and more holistic approach to problem-solving strategies [59,76,150].

A critical issue will be incorporating systems science and transdisciplinary approaches into OSH training without overburdening an already demanding curriculum.

One possible approach is to train OSH professionals to be aware of, liaise with and work transdisciplinarily with related fields. At the least, collaboration on OSH topics should be encouraged between different disciplines. Another approach is to incorporate this new thinking into existing courses through individual or group projects and exercises that address Total Worker Health issues and global worker well-being [77]. Key content areas that might be addressed in these training activities are shown in Table 3 [151,152].

Table 3. Key Content Areas for Training OSH Professionals [152].

Content Area	Examples
New Investigation Strategies	Biopsychosocial model of OSH Systems thinking Futures thinking
Technology	Digitalization Societal reliance on technology Human-machine interface
Organizational Development	Organizational change Change management
Data Techniques	Data collection Data management Data analysis Data interpretation
Interpersonal skills	Social skills Communication Emotional intelligence Transdisciplinary teamwork

3.3. Future OSH Research and Practice

The second preparatory workshop examined how the future of work will impact OSH research and professional practice [19]. OSH researchers and practitioners will face new and exacerbated challenges in the future: new forms of work organization and technologies; continued erosion of the line between work and nonwork; electronic monotony; lack of organizational commitment to safety; emotional labor; digital surveillance; and expansion of psychosocial strain in many disease processes ("diseases of despair") and work hazards in the context of socioeconomic, racial and gender disparities [153,154].

To address these challenges in OSH research, it is important to identify the pertinent affected parties and collaborators and examine ways to incorporate them into the discussion. The use of participatory research methods, which involves listening to workers, learning about their lived experiences, and then partnering with them to document problems and envision changes, has a rich history [155–159]. There are established participatory research methods engaging workers as partners to design effective and feasible solutions, although conducting and evaluating such research can be difficult [128]. Realistic evaluation, which is frequently used in public health research and in approaches such as Contribution and Impact Analysis, may be required [160,161].

The OSH field will also need to identify evidence-based approaches likely to move others—particularly employers—to action that benefits workforce health and safety. One useful approach may be documenting costs to employers or society to fix a problem [160,161]. Another example is showing the positive effects of high-quality jobs and employee involvement on organizational performance and employee well-being [162,163]. Additional research on the interaction of working conditions with broader economic and political issues (such as housing and transportation) will also be needed [89].

Addressing the principles of well-being and decent work in future OSH research will face important obstacles, such as those illustrated by the Healthy Work Campaign [164]. These include: (1) lack of consensus on a definition for "healthy work"; (2) lack of consensus on the role of work stressors in ill health; (3) ideological beliefs about health and illness; (4) economic barriers to fixing unhealthy working conditions; (5) inadequate tools to diagnose sick and unhealthy workplaces; (6) lack of fully-tested, workable interventions and implementation strategies for workplace change; and (7) lack of enforceable standards to ensure that work is safe and promotes health. Additionally, the argument has been made that "the shortfall in 'good jobs' can be viewed as a massive market failure—a kind of gross economic malfunction and not just a source of inequality and economic exclusion [165]." These obstacles can be overcome in part with innovative research approaches, engaging

different allies and partners, especially those outside the usual framework, particularly intermediary organizations [166–171].

3.4. Tools to Measure Well-Being of Workers

Operationalizing and measuring well-being were key issues raised in the Ex4OSH conference. Two tools that were presented were the Thriving from Work Questionnaire and the Worker Well-Being Questionnaire (WellBQ).

3.4.1. Thriving from Work Questionnaire

Thriving in a work environment has been described as "a state of positive mental, physical and social functioning in which workers' experiences of their work and working conditions enable them to thrive in their overall lives, contributing to their ability to achieve the full potential in their work hours and community" [172]. The Thriving Framework Questionnaire is a validated 87-item survey that has both a long and short form. It is intended for use across working populations or organizations; in periodic surveillance across a worker population or within an organization; or as an organizational diagnostic tool to identify priority areas for interventions to improve worker well-being [172]. Currently the investigators are examining thriving across various multiple work settings. One ongoing study, for example, is using the tool to identify relationships of working conditions (such as supervisor support, safety climate, or scheduling) and workplace policies and practices with workers' thriving from work [172].

3.4.2. NIOSH Worker Well-Being Questionnaire

There is no widely accepted definition of well-being. Some instruments capture aspects of it, but none capture the totality of well-being related to work. In this regard, the NIOSH WellBQ (available at https://www.cdc.gov/niosh/twh/wellbq/default.html (accessed on 11 April 2022) represents an important step forward. This 68-item questionnaire was recently released for public use, after testing and validation. It is based on a framework that considers well-being as an integrative concept that characterizes the quality of life with respect to an individual's health and work and related environmental, organizational, and psychosocial factors. It also examines the experience of positive perceptions and presence of constructive conditions at work and in other areas of life that enable workers to thrive and achieve their full potential [119].

3.5. Psychosocial Hazards and Adverse Mental Health Effects

The literature is rich on psychosocial hazards and the risks related to future changes in work [1–3,14,16,18,78,80,90,99,113,117,129,170–175]. Evidence of the increasing prevalence and incidence of adverse mental health effects and their costs to workers and organizations is also growing [5,11,113,176–178]. These effects include anxiety, depression, loneliness, suicidal ideation, psychological strain, and related physical conditions, including cardiovascular diseases, musculoskeletal disorders, and other systemic disorders. Although these hazards and effects predate the COVID-19 pandemic, they were accelerated by it.

The conditions of work can adversely influence psychological responses, particularly when there are high demands and low control or limited latitude for decision-making [162]. Lacking a sense of purpose can also be a factor that, alone or combined with work conditions, leads to adverse physical and mental effects [11,100,164,177,179].

A key theme highlighted in the workshops and Ex4OSH is the awareness of increasing prevalence of psychosocial hazards and mental health disorders related to work [17,18,129,179]. There is a growing number of psychosocial hazards brought about by new forms of work organization; precarious employment; stress; exploitation; migration; irregular schedules; low decision latitude; lack of organizational commitment to safety; absence of a strong social contract; and work hazards in the context of socioeconomic, racial and gender disparities and demographics [10,80,99,113,125,178,180–186].

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While there is some guidance in various countries on assessing and preventing adverse effects from psychosocial hazards this is still a relatively new area for OSH [16,173,187]. Some countries do have standalone guidance. Canada, for example, initiated *Psychological Health in the Workplace* in 2013 [188] and New Zealand initiated *Psychosocial hazards in work environments and effective approaches for managing them* in 2019 [90]. One approach that could have broad applicability is the International Standards Organization (ISO) 45003, *Occupational health and safety management—Psychological health and safety at work: guidelines for managing psychosocial risks*, which represents the most comprehensive global effort to address psychosocial hazards and is intended for use in conjunction with ISO 45001 (*Occupational health and safety management systems*) [189]. Another strong approach to addressing psychosocial hazards is the development of a psychosocial safety climate [190,191]. Psychosocial safety climate refers to "a climate for psychological health and safety in workers," reflects the balance of concern by management about psychological health versus productivity and is an objective in building a psychologically productive workplace [54,190].

3.6. Skilling, Upskilling and Improving Job Quality

Much of the concern about the future of work is that, owing to technological advances, workers may not be able to obtain or keep jobs because of inadequate skills [3–5]. Many jobs of the future also do not currently exist, making preparation and transitioning uncertain [4,192]. Such skill-related issues affect both white-collar and blue-collar workers and generally arise because of technological changes [193]. White collar workers fear job loss due to replacement by artificial intelligence, algorithms, and robots. Skills mismatch and development and skills transfer issues affect blue collar workers in skilled trades. One interesting approach presented at Ex4OSH to this dilemma is the "union-construction model" [194], built on the foundation of peer-to-peer training and the apprenticeship program. This model has had wide success in the United States and apprentice programs are effective worldwide [195].

The limitations workers face relate not only to evolving personal skills and competencies but also to job quality and wages [196]. In the United States in 2017, 44% of working adults, aged 26–64 years, earned \$15/h or less and these disproportionately were women or racial minorities [196]. While there are beneficial effects of the standard approaches to job quality—regulation, strengthening countervailing power of workers and skill framing—the efficiency of these could be enhanced by using an industry or sector strategy [196]. Improving job quality can improve both the work experience and organizational productivity and therefore deserves greater emphasis from the OSH community.

3.7. Soceioeconomic Influences

Future OSH hazards will be increasingly influenced by socioeconomic factors such as business organization, wages, industry specific public processes, insurance, unemployment, and efforts to bring about decent work [27,34,41,52,55,60,80,81,87,197–203]. Although there has not been a systematic assessment of the role of macroeconomic factors on occupational morbidity, mortality and injury, there is literature that identifies individual socioeconomic factors. Increasing GDP, for example, has been related to decreasing occupational injuries in Austria, although no direct causal linkage could be ascertained and generalization to other countries is limited [204].

There is also evidence supporting a link between job and income insecurity and negative health outcomes [187,201,202,205]. A critical means to address workplace hazard and adverse effects involves placing a systematic focus on organizational culture and climate [54,185,190,192,206]. Changing organizational design and work arrangements such as platform work are linked with job flexibility and have implications for work-life. This may be a growing issue in the future [82]. To cope with this, stricter government policy and enforcement as well as agreements between employers' organizations and trade unions may be needed.

3.8. Climate Change

Climate change, more severe than in the past, will influence both OSH training and research. *The Lancet* has argued that "climate change is the biggest global threat of the 21st century and tackling climate change could be the greatest global opportunity of the 21st century" [207]. Climate change overlaps many of the other emerging themes. Workers are one of the first groups to be adversely affected by climate change, reflected in greater and more serious exposures, and they manifest health effects earlier than the general population [50,208–212], akin to being "climate canaries" [211]. Climate-related worker hazards include increased ambient temperature; air pollution; ultraviolet radiation exposure; extreme weather; vector-borne diseases and expanded habitats; industrial transitions and emerging industries; and changes in the built environment [209]. In addition to the many physical effects identified, adverse mental health effects from climate change are predicted to grow extensively in the future [207,210]. The distribution of the deleterious effects of climate-related factors not only occurs by occupation and industry but in conjunction with social and economic inequalities. Consequently, it will be essential to include climate-related knowledge in OSH curricula and address climate-related hazards in research and policy development.

3.9. COVID-19 Pandemic Influences on OSH

The COVID-19 pandemic is an historic moment in human history, with a large impact on work. All workers around the world have been affected by the pandemic [213]. Broadly speaking, the entire population has faced new psychosocial risks, but a comprehensive approach to these risks is lacking. In response, OSH practitioners should make the link between occupational health and public health evident [80,213,214]. Unfortunately, it is often difficult to understand or prevent psychosocial risks and hazards because they are not necessarily tangible, sometimes emerging only when their impact is seen [16]. The ILO, however, has presented a holistic approach that can address the broad range of psychosocial factors in the world of work [214].

Prior to the pandemic, worker well-being was already decreasing in many sectors [118, 164,214–216]. The pandemic further influenced this decline by accelerating the realization of future predictions for the well-being of the workforce [18,122,215]. Most investigators could not access workers at worksites to conduct intervention research [217–219]. The pandemic illustrated the utility of Total Worker Health, an integrated approach that avoids the traditional siloes of OSH by focusing comprehensively on the whole worker [219]. Total Worker Health may advance worker equity by encouraging employers to look beyond work and consider how they can help workers on broader issues, especially during times of public crises (e.g., pandemics).

3.10. Strategic Foresight

Given the speed of change facing OSH and growth in challenges and uncertainties, new approaches to preparing for the future are paramount. Strategic foresight is an action-oriented planning discipline that can help test current strategy and create transformative change. Strategic foresight recognizes that the future is not predetermined or predictable, and it is designed to ask questions such as what may be coming, how it might affect us, and what we can do today to move toward a desired future [151]. The practice of strategic foresight involves both mapping, or creating visions of, the future and assessing the implications and critical issues associated with those future views [151,220]. Together, these activities can then reduce the likelihood that we are unprepared for future change. The insights gained from strategic foresight can be used as a complement to, rather than a substitute for, traditional strategic planning that relies heavily on historic data and trends [151]. The number of organizations using strategic foresight to create and explore plausible work future is growing worldwide [151].

Despite its popularity as an input to many different types of business and decision-making efforts, strategic foresight has been underutilized in OSH. To help bring the practice

to OSH, NIOSH has developed a tailored approach to strategic foresight that supports the expanded focus [151]. The NIOSH Foresight Framework for OSH builds on the work of Bishop and Hines [220,221] and involves six interrelated stages: framing the OSH domain; scanning for signals of change; developing plausible future scenarios; exploring implications and options of plausible futures; designing strategies to prepare for and influence the future; and monitoring for new signals of change [151,152,222]. Well-known OSH resources, such as the NIOSH TWH program's list of extensive issues related to enhancing working well-being, can help to focus future foresight efforts within a meaningful OSH domain [151,152]. To ensure that strategic foresight can be sustained in OSH, it will be necessary to build capacity within the OSH community of research to practice. The Foresight Competency Model developed by the Association of Professional Futurists can serve as a guide for developing knowledge, skills, and abilities within OSH [151,152,220].

4. Conclusions

The workshops and conference meetings described in this article provided a view of an expanded focus for the OSH field that considers the cumulative and compounding effects of a broad list of factors and the interactions they have on worker health outcomes, particularly mental health outcomes and well-being [13,25,80,90,152]. However, understanding and proactively managing the ever-growing and evolving list of risk factors and outcomes requires us to expand not only how we think about OSH but the urgency with which we act to address these changes.

The meetings added depth to discussion of a model for an expanded focus for OSH (Figure 1), which was first published in 2019 and calls for the expansion from traditional OSH focus to one that includes consideration of the impact of personal and socioeconomic factors over the working lifetime, aimed at achieving worker and workforce well-being. Well-being has long been considered in OSH but often merely as a descriptive aspiration in a conjunctive phrase (" . . . and well-being") rather than as a measurable variable in research or a goal, target, or indicator in policy and practice. The meetings also examined the operationalization and use of the concept of well-being in OSH, setting the stage for evolution of the field to address complex and difficult issues in the work of the future.

Recommendations from the first two subject matter expert workshops [19,76] focused on how the future of work will shape the OSH professional and research and practice in the future. Critical in training new OSH professionals will be the incorporation of systems thinking, skill in negotiations and understanding power relations, transdisciplinarity and foresight approaches into the curricula. New training methods and approaches will be needed to meet the demands of an increasingly mobile and distributed workforce, such as rapid-readiness training. In an expanded focus for OSH, future research and practice will require a broader view of complex issues and transdisciplinary paradigms to better prepare for new models of employment. The Ex4OSH conference reiterated the need to incorporate well-being as an overarching construct for OSH research, practice and policy. Tools such as the NIOSH WellBQ and Thriving from Work Questionnaire provide a systematic approach to operationalizing these constructs.

A major driver of well-being is the prevention and control of adverse effects from psychological hazards. The OSH field will need to be adept at compliance and implementation of innovative psychological health standards such as in Canada (CAN/CSA–Z1002–13/BNQ4700-803/2013) [188] and the ISO 45003 standards [189].

The impact of climate change on the quality of work and on mental health will also be more pronounced [196,210]. The growing occupational impacts of climate-related hazards still lack adequate investment in research, surveillance, and risk management.

If the OSH field is to address the new complexities of the future, it will need to have a paradigm that supports an expanded focus. The biopsychosocial [86,145] and Total Worker Health [74] paradigms can serve as a foundation on which the OSH field can position itself to have such an expanded focus that more clearly envisions well-being for workers.

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There are many practical, legal, and social considerations when using the concept of well-being in occupational safety and health. Key issues pertain to worker privacy on factors that may influence the line between worker and employee responsibilities; costs related to well-being interventions; absence of a clear legal framework; and concern that addressing well-being will dilute scarce resources that would be needed for traditional OSH hazards [223]. Nonetheless, these challenges are surmountable, and data are increasing to link well-being with worker, enterprise, and national productivity. This may motivate broader adoption of the concept.

The meetings described herein represent an effort to ensure that the field of OSH looks forward so that it continues to be relevant and impactful and is more valuable to society because it takes a broader view of the issues affecting workers and the workforce. Clearly, the topics and speakers of these meetings reflect a selective process by the authors and to some extent their points of view. This article captures the major themes of the Ex4OSH conference and workshops: worker health inequalities; training new OSH professionals; future OSH research and practice; tools to measure well-being of workers; psychosocial hazards and adverse mental health effects; skilling, upskilling and improving job quality; socioeconomic influences; climate change; COVID-19 pandemic influences on OSH; and strategic foresight. Attention to these themes will be critical if the OSH field is to be effective in the future. Ultimately, these themes are generally conceptual as were most of the meetings. There is need for distilling the themes to practical outputs and guidance that is beyond the scope of this paper, but necessary if there is to be an expanded focus for the OSH field. Moreover, the effectiveness of the OSH field depends not only on expertise and research but at least as much on legislation and strategies to convince and, if necessary, require organizations to take specific actions.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, or other affiliated organizations of the authors.

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