Age Differences in Return-to-Work Following Injury

Understanding the Role of Age Dimensions Across Longitudinal Follow-up

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Objectives: To examine the overall association between chronological age and return-to-work (RTW), and understand if existing data could be used to better understand the role of age-related dimensions (functional, psychosocial, organizational, life-stage) in explaining these associations. **Methods:** We used survey data from a prospective cohort of injured workers in Victoria, Australia. Path models examined the relationship between chronological age and RTW, and the proportion mediated via age dimensions. **Results:** Older chronological age was associated with non-RTW, although the pattern was not observed consistently across follow-up surveys. A proportion of the overall relationship between chronological age and non-RTW was explained by functional and life-stage age and RTW status at previous time points. **Conclusions:** Findings underscore the importance of moving beyond age measured only in chronological years, towards more complex conceptual and analytical models that recognize age as a multidimensional construct.

Keywords: functional age, injured workers, life-stage age, mediation, older workers, organizational age, path analysis, psychosocial age, workers' compensation

BACKGROUND

Older age tends to be associated with negative return-to-work (RTW) outcomes following a workplace injury, such as longer time to RTW, multiple recurrences of work absence following an initial RTW attempt, and greater overall duration of wage-replacement.[1–5] However, only a small subset of studies have examined the underlying factors that are responsible for the differences across age groups.[1,4–6] A study using workers' compensation data have found that age-related differences in the prevalence of pre-existing chronic conditions might explain a proportion of the variance in sickness absence duration, rather than the chronological age of the worker.[1] A study using survey data collected from injured workers[6] also found that injury severity, injury-related surgery and physical functioning scores accounted for age-related differences in RTW. Across these studies, only a moderate proportion of the overall association between older age and non-RTW was explained by the presence of physical, clinical and injury-related characteristics, suggesting that other factors or mechanisms may account for the remaining effect of age on RTW outcomes.

Given the impact of RTW outcomes on well-being, quality of life,[7,8] and claim costs,[9,10] it is important to conceptually understand age effects and whether age is a proxy for other age-related factors as they may signal the potential for targeted interventions.[11] However, there are several important limitations that need to be addressed from previous research. First, previous studies tend to focus only on chronological age (ie, the age of the worker in calendar years), despite the acknowledgement that age can be measured using a variety of dimensions.[12–15] By distinguishing chronological age from other age dimensions, we can gain a better understanding of underlying pathways that contribute to age-related differences in work outcomes.[16–20] A paper by Sterns and Doverspike[12] outlined four additional age dimensions that may be of relevance to work outcomes. *Functional age* relates to worker performance and work functioning within the context of employment. As individuals age chronologically, they may experience declines in physical or cognitive functioning, as well as the development of chronic conditions that can result in activity limitations.[1,13,21] *Psychosocial age* relates to self-perceptions of how old an individual believes they look, feel, act or desires to be, and social-perceptions of how old others appraise an individual to be.[22] *Organizational age* relates to the job or employment trajectory of individuals over time, and is often measured using indicators of career stage, job tenure or skill obsolescence. Finally, *life-stage age* relates to the various role changes and life events that occur throughout the life course, such as finishing school, finding a partner, having children, starting a career, labour market experiences of a spouse/partner, caregiving responsibilities for older relatives or a spouse/partner and retirement.[13]

Age dimensions have been linked with work outcomes such as motivation to continue working and labour market participation in previous studies.[12,13] However, in relation to RTW outcomes, there are few studies and, those that exist, have focused only on individual subsets of each dimension (eg, functional age),[1,5,6] in part due to lack of comprehensive data and measurement challenges.[13] Moreover, previous studies have ignored the potential for competing pathways by not examining all age dimensions within one conceptual model, despite evidence that the dimensions exhibit both positive and negative relationships with subsequent outcomes.[13,14] In contrast, a simultaneous approach to examining the multidimensionality of age could help counter age-related stereotypes and negative perceptions about older workers by identifying causal pathways that both promote and hinder successful RTW outcomes.[19–22]

The most direct way to measure the above age dimensions would be to incorporate measures using validated scales developed in previous studies. However, these measures are not always available in existing data sources that were not originally collected to directly examine age dimensions.[2] If there are aspects of age dimensions that could be captured by existing indicators, then this

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This research was funded by a Linkage Grant from the Australian Research Council (LP130100091). The funding sources had no role in the writing of the manuscript or in the decision to submit the manuscript for publication.

Ethical approval was obtained from the Monash University Human Research Ethics Committee (#CF13/3312-2013001735) and the University of Toronto Health Sciences Research Ethics Board (#36039). Participants gave informed consent before taking part in the study.

The authors report no conflicts of interest.

Clinical significance: This study shows that while older age may be associated with non-RTW following injury, age effects may not be consistent across follow-up. Age-related dimensions such as functional and life-stage age may explain a proportion of the overall relationship between age and RTW, although other dimensions and factors may be relevant.

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DOI: 10.1097/JOM.0000000000002029

would allow for the measurement of age using a broader range of data sources with relevant work outcomes where direct measures had not been collected.

This paper aimed to better understand differences in RTW outcomes across age groups by exploring whether dimensions of age could be generated using existing datasets and by assessing the role of different conceptualizations of age. Objectives were to: (1) Demonstrate an approach that could be used to create indices of functional, psychosocial, organizational and life-stage age based on available survey measures where no direct measure is available; (2) Examine the overall association between chronological age and RTW outcomes across longitudinal follow-up; and (3) Examine the extent to which each age dimension explains the overall relationship between chronological age and RTW, and whether there is a remaining direct proportion not mediated by the age dimensions.

METHODS

We used survey data collected from a prospective cohort of workers' compensation claimants in Victoria, Australia. In Victoria, approximately 85% of the state's labour force is covered by the workers' compensation system, which provides insurance for wage-replacement and health care expenditures in the event of a work-related injury or illness. The sampling frame, recruitment procedures, and response rates are published in more detail elsewhere.[23] In brief, the sampling frame was based on a population of claimants with an accepted claim for work-related psychological or musculoskeletal injury resulting in 10 or more days of work absence, which is the administrative threshold for receipt of compensation from the system. Participants aged 18 years and older were recruited over the 2014 to 2015 period from monthly random samples of claimants identified by the compensation system, with a total of $n = 2495$ claimants included in the sampling frame.

Of the $n = 869$ claimants who participated at T1 baseline interview (approximately 3.5 mo post-injury), $n = 632$ (73%) completed the 6-month follow-up interview (T2), and $n = 572$ (66%) completed the 12-month follow-up interview (T3). We included all available data for individuals who completed the baseline survey and who had complete data on study covariates ($n = 776$, 89%), excluding individuals with missing data ($n = 93$).

Return-to-work status (RTW) was defined as whether the worker self-reported being back at work, at the time of survey, for a sustained period of at least one month. Responses were coded as 1 ''Working >1 month'', 2 ''Working but <1 month'', 3 ''Off work but made attempts to RTW'', and 4 ''Off work'', with higher values denoting non-RTW. Outcomes were measured at T1, T2 and T3 for respondents who completed the respective surveys.

Chronological age: Our primary explanatory variable was worker age at time of injury. For descriptive and regression models, we examined age as a categorical variable (18 to 34, 35 to 44, 45 to 54, and 55+ y). The 18 to 34 group was selected as the reference category. For path models, we examined age as a continuous variable (years).

Functional age was defined as a summary index based on the presence of four chronic conditions (arthritis, high blood pressure, diabetes, and heart disease); and work activity limitations as a result of health conditions, in reference to pre-injury activities, ascertained from four scale items (restrictions in the amount of activity that could be done at work, the type of activity, the pace of work, and the way in which work was done).[24] Chronic conditions were self-reported and defined as long-term conditions that have lasted or are expected to last 6 months or more and that have been diagnosed by a health professional. Each of the eight items were coded as binary variables (yes/no to the presence of each chronic condition or work restriction) and summed to create a composite index.

Psychosocial age was defined as self-rated perceptions of whether the worker's age would influence or has influenced the speed of recovery, and if so, whether this resulted in the recovery being slower or faster. Responses were coded as 1 ''Faster speed of recovery due to age'', 2 ''No influence of age on recovery'' and 3 ''Slower speed of recovery due to age'', with higher scores denoting a negative influence. We conceptualized this measure as an indicator for psychosocial age, given its emphasis on self-perceptions of the aging process,[13,22] although we note the lack of validated usage of this item in previous studies.

Organizational age was defined as the number of years of tenure with the current employer at time of injury, coded as 1 ''<1 year'', 2 ''1 to 2 years'', and 3 ''3+ years'', with higher scores denoting greater tenure.

Life-stage age was defined by spousal working status and children aged ≤16 years living in the household. Spouse/partner living arrangement/working status was coded as 0 ''Not living with a spouse or partner'', 1 ''Spouse/partner working full-time'', 2 ''Spouse/partner working part-time'', and 3 ''Spouse/partner not working'', with the highest score denoting living with a spouse/partner with less labour market attachment. Children in the household was coded as 0 ''One or more children'' and 1 ''No children living in the household''. These two variables are commonly used markers of age across the life span.[12,13]

Covariates: All models were adjusted for the following covariates based on hypothesized relationships with chronological age, age dimensions and RTW outcomes[3]: sex (male, female); injury type (musculoskeletal, psychological); unionization status of workplace (yes, no); usual work hours (<30 h, 30 to 39, 40+); injury severity (very severe vs severe/moderate/slight/very slight); and pre-injury psychosocial work conditions (physical demands, mental demands and job autonomy, with higher scores denoting better conditions).

Analysis

For objective #1, descriptive statistics (counts, proportions) compared the distribution of age dimension items by chronological age group.

For objective #2, we ran ordinal logistic regression models to examine the overall relationship between chronological age and the odds of having higher levels of the outcome (ie, being off-work) compared to lower levels (ie, having sustained RTW). Models were estimated separately for each follow-up time point (T1, T2 and T3), adjusting for covariates and lagged levels (T-1) of the respective outcome variable where applicable. Models were fully-adjusted for covariates, but unadjusted for the age dimension mediators to quantify the total effect of chronological age.[25]

For objective #3, path analyses examined the mediating role of age dimensions in explaining the total relationships between chronological age and non-RTW (at T1/T2/T3). The following relationships were examined: (1) the association between chronological age and each age dimension (a-paths); (2) the association between age dimensions and non-RTW (b-paths); (3) the indirect association between chronological age and non-RTW, as mediated via each age dimension ($a*b$ paths); and (4) the remaining direct association between chronological age and non-RTW (c'-path). The total relationships between chronological age and non-RTW (c-path) were calculated as the sum of the indirect and direct paths. We accounted for the longitudinal structure of the data by examining both cross-sectional (X1 → M1 → Y1) and longitudinal (X1 → M1 → Y2/Y3) mediated effects.[26]

Regression and path models were run using Mplus 8 (Los Angeles, CA). Path models used a robust, weighted least-squares estimator (WLSMV), which models any categorical endogenous variables as continuous latent response variables underlying the probability of membership in different levels of each observed category. Standardized path coefficients are reported along with bias-corrected and bootstrapped 95% confidence intervals. Selected covariates with non-significant pathways were removed to improve model fit.

TABLE 1. Distribution of Study Covariates at Baseline Survey

	Chronological Age (y)					
	18–34	35–44	45–54	55+	Total	
	$n = 173$	$n = 188$	$n = 249$	$n = 166$	$N = 776$	
	Col. %	Col. %	Col. %	Col. %	Col. %	*P* value
Sex						
Male	55%	64%	51%	57%	56%	0.064
Female	45%	36%	49%	43%	44%	
Injury type						
Musculoskeletal	81%	74%	79%	72%	77%	0.122
Psychological	19%	26%	21%	28%	23%	
Union status						
No	52%	46%	36%	33%	41%	0.001
Yes	48%	54%	64%	67%	59%	
Work hours per week						
<30	8%	6%	17%	18%	12%	0.008
30–39	51%	52%	46%	48%	49%	
40+	41%	42%	37%	34%	38%	
Injury severity						
Very slight to severe	69%	60%	63%	59%	63%	0.321
Very severe	31%	40%	37%	41%	37%	
	Mean	Mean	Mean	Mean	Mean	*P* value
Psychosocial work conditions						
Low physical demands (5–25)	8.5	10.5	11.2	12.1	10.6	<0.001
Low psychological demands (6–30)	15.2	16.8	16.6	16.9	16.4	0.042
Job autonomy (5–25)	15.3	16.7	17.1	17.5	16.7	0.001

Stratified by chronological age group; Victoria, Australia; $N = 776$.

RESULTS

Table 1 presents the distribution of study covariates, by chronological age group. Overall, 44% of the sample were female and 77% had a musculoskeletal injury. Fifty-nine percent of the sample worked for unionized employers (with a greater proportion among older workers) and worked 30 to 39 hours per week (with older age groups working less hours). A large proportion of the sample rated their injury as being very severe (37%), but this did not vary significantly by age group. Mean scores for physical demands, psychological demands and job autonomy were rated more positively among older age groups.

Objective #1: Distribution of Age Dimensions

Table 2 presents the distribution of age dimension items across chronological age groups. The distribution of each item varied significantly across chronological age groups ($P < 0.05$). For *functional age*, older chronological age groups had a greater prevalence of chronic conditions and greater restrictions in pre-injury work ability. For *psychosocial age*, older chronological age groups were more likely to perceive their age as having a negative impact on the speed of their recovery (compared to none or positive impact). For *organizational age*, older chronological age was associated with greater years of job tenure. For *life-stage age*, older chronological age groups were more likely to have a spouse/partner that was not working, whereas both the youngest and oldest age groups were less likely to have children ≤16 years in the household.

Objective #2: Total Relationship between Age and RTW

Table 3 presents the overall relationship between chronological age non-RTW at follow-up. Older chronological age was associated with a greater odds of being off work at T1 in a graded fashion (eg, at T1: 55+ age group vs 18 to 34 y: OR 2.97). At T2 and T3 (adjusted for lagged T-1 outcomes), there was no consistent gradient in point estimates across age groups, although the 55+ age group had a greater odds of non-RTW at T2 (OR 2.08) and the 45 to 54 age group had a decreased odds of non-RTW at T3 (OR 0.41).

Objective #3: Role of age Dimensions

Figure 1 presents the path models examining the mediating role of age dimensions in explaining non-RTW outcomes. See Table 4 for the accompanying estimates. Goodness-of-fit of the final path model was adequate based on various indices (ie, Chi-Sq *P* value = 0.40; Root Mean Square Error of Approximation = 0.008; Comparative Fit Index = 1.00; Tucker Lewis Index = 0.99).[27]

We found a total association (*c*-path) between older chronological age and non-RTW at T1 (standardized beta 0.182) and T2 (standardized beta 0.137), but not statistically significantly at T3 (standardized beta 0.069). We also found that older chronological age was associated with each of the four age dimensions at T1 (*a*-paths), with standardized betas ranging from 0.224 to 0.486 across age dimensions. Two of the age dimensions also were significantly associated with non-RTW at T1 (life-stage age) and T2 (functional age). Residual covariances between each pair of age dimensions ranged from standardized beta 0.021 to 0.096, suggesting minimal overlap between the dimensions.

For T1 outcomes, the indirect association ($a*b$ paths) of chronological age on non-RTW was significant only for life-stage age (standardized beta −0.020), accounting for 8% of the absolute total association (0.020 divided by 0.265). This pathway was in the "protective" direction, whereby older chronological age was associated with a greater life-stage age index, yet greater life-stage age was associated with better RTW outcomes. The remaining direct

TABLE 2. Distribution of Age Dimension Items at Baseline Survey

	Chronological Age (y)				
	18–34	**35–44**	**45–54**	**55+**	
	***n* = 173**	***n* = 188**	***n* = 249**	***n* = 166**	
Functional Age	**Col. %**	**Col. %**	**Col. %**	**Col. %**	***P* value**
Chronic conditions (% yes)					
Arthritis (% yes)	4%	7%	17%	31%	<0.001
High blood pressure (% yes)	<3%	11%	21%	34%	<0.001
Diabetes (% yes)	<3%	4%	8%	11%	<0.001
Heart disease (% yes)	<3%	<3%	<3%	6%	0.004
Work activity limitations (% some, most, all of the time)					
Restricted amount of activity?	13%	12%	15%	29%	<0.001
Restricted type of activity?	10%	11%	15%	25%	0.001
Having to slow down?	11%	14%	18%	26%	0.002
Having to change the way done?	13%	17%	20%	34%	<0.001
Psychosocial Age	**Col. %**	**Col. %**	**Col. %**	**Col. %**	***P* value**
Perceived influence of age on speed of recovery					
1 Positive influence (faster)	45%	15%	5%	4%	<0.001
2 No influence	46%	60%	58%	54%	
3 Negative influence (slower)	9%	25%	37%	41%	
Organizational Age	**Col. %**	**Col. %**	**Col. %**	**Col. %**	***P* value**
Employment tenure					
<1 year	27%	16%	8%	6%	<0.001
1–2 years	35%	17%	14%	10%	
3+ years	39%	66%	79%	84%	
Life-Stage Age	**Col. %**	**Col. %**	**Col. %**	**Col. %**	***P* value**
Spouse/partner living/working status					
1 Not living with a spouse/partner	48%	35%	30%	36%	0.003
2 Spouse/partner working full-time	30%	32%	42%	29%	
3 Spouse/partner working part-time	9%	19%	15%	15%	
4 Spouse/partner not working	14%	14%	13%	21%	
Children ≤16 years in household					
0 'One or more children'	24%	59%	38%	13%	<0.001
1 'No children'	76%	41%	62%	87%	

Stratified by chronological age group; Victoria, Australia; $N = 776$.

TABLE 3. Relationship Between Chronological Age and Non-RTW Status (Proportional Odd Ratios of Being Off Work vs Working for a Sustained Period) at Given Follow-up Surveys

	Non-RTW Status		
	T1	**T2***	**T3†**
	***N* = 776**	***N* = 566**	***N* = 456**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Age group			
18–34 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
35–44	**1.75 (1.14, 2.69)**	1.48 (0.82, 2.68)	0.83 (0.42, 1.65)
45–54	**2.27 (1.53, 3.38)**	1.28 (0.73, 2.26)	**0.41 (0.21, 0.82)**
55+ y	**2.97 (1.88, 4.71)**	**2.08 (1.16, 3.73)**	0.87 (0.44, 1.71)

All models adjusted for covariates (sex, injury type, injury severity, union status, work hours, and pre-injury psychosocial work conditions), but exclude the age dimension mediators.

*Additionally adjusted for lagged RTW status (T1).

†Additionally adjusted for lagged RTW status (T2).

association (c'-path) of older chronological age on non-RTW at T1, not via age dimensions, was standardized beta 0.203 (77% of the absolute total association). Note that in the presence of suppression effects (ie, both positive and negative indirect pathways),[28] the total sum of mediating pathways could be less (rather than greater) than the direct association, hence the calculation of proportion mediated using the absolute values.

For T2 outcomes, the total association between chronological age and non-RTW was mediated via functional age (standardized beta 0.044, 19% of the absolute total association); and via non-RTW status at T1 (standardized beta 0.087, 54% of the absolute total association). The remaining direct association of older chronological age on non-RTW at T2 (ie, not via age dimensions or RTW at T1) was not statistically significant (standardized beta 0.022).

DISCUSSION

This study aimed to better understand age-related differences in RTW using existing survey data from a prospective cohort of injured workers in Victoria, Australia. Our study developed distinct measures of underlying age dimensions that were strongly associated with chronological age using data where no direct measure is

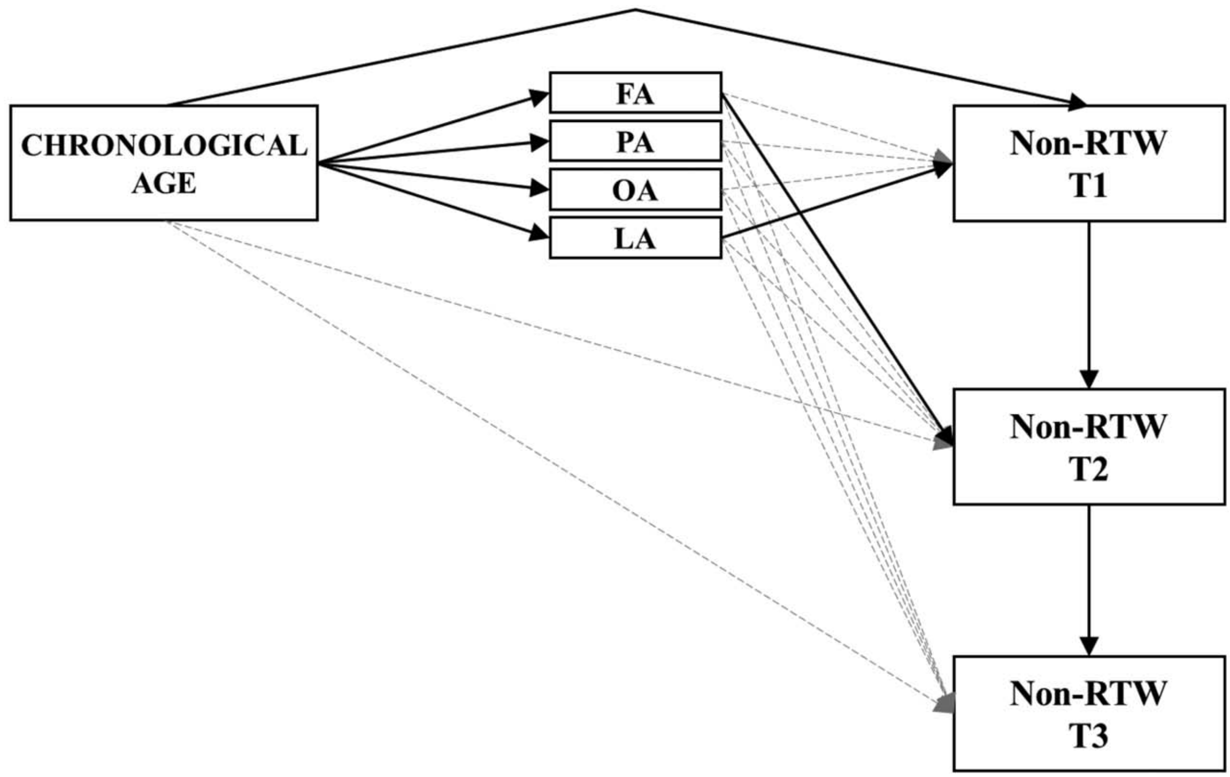

FIGURE 1. Path models examining relationships between chronological age, age dimensions and non-RTW status.[1–4] Statistically significant estimates are highlighted with solid arrows; non-significant estimates with dashed arrows.

available. We also found that older chronological age was associated with non-RTW in a graded fashion, but that this pattern was not observed consistently across study follow-up waves. Finally, we found that a proportion of the overall relationship between age and non-RTW was explained by functional age and RTW status at previous time points; and that life-stage age had a protective effect on RTW.

Objective #1: Creating Measures of Age Dimensions

We achieved our objective of identifying at least one indicator of each age dimension using survey data that was not explicitly collected to measure age. As some indicators (eg, chronic conditions, years or job tenure, children in the household) are commonly available in existing labour market and health surveys, these measures could be readily incorporated into future studies to provide a stronger conceptualization of age. The strong links (ie, concurrent validity) between chronological age and each dimension, yet low correlations between the dimensions, suggest that our derived measures are a good fit with multidimensional age constructs as proposed in existing measurement models.[12,13] These models were previously developed in relation to general working-age populations but, to date, have not been validated among samples of injured workers. At the same time, psychosocial age and organizational age were only measured with one variable each, highlighting the limitations in defining age dimensions using existing data without direct survey questions.[15,29] We also were unable to measure other facets of organizational age as outlined in existing models,[12,13] such as career stage or skill obsolescence. Together, these observations suggest that inclusion of simple and parsimonious measures of age dimensions from existing survey data may contribute to a well-developed measure of a given age dimension, although future research and survey initiatives will likely require the inclusion of direct survey measures for a fuller assessment of age.

Objective #2: Chronological Age and RTW

Although our findings of an overall age gradient in RTW outcomes are consistent with previous studies,[3] the lack of robust association once we examined the entire trajectory of follow-up suggests that a more nuanced understanding is required. First, the time-varying nature of RTW outcomes suggests that age effects may not be adequately represented by a single summary measure of effect. This points to the need for the collection of longitudinal survey data to characterize the role of age across the length of study follow-up.[7] Second, the non-consistency of age differences across the entire follow-up trajectory may have relevance for the development of interventions, which could be targeted towards the earlier

TABLE 4. Standardized Coefficients (95% Confidence Intervals) for Path Models Examining Chronological Age, Age Dimensions and Non-RTW Outcomes[1-4]

T1 Survey	**Age → Mediator**	**Mediator → Outcome**	**Age → M → O**
Indirect			
via FA	**0.301 (0.235, 0.367)**	0.032 (−0.049, 0.112)	0.010 (−0.014, 0.034)
via PA	**0.486 (0.412, 0.552)**	0.020 (−0.087, 0.125)	0.010 (−0.041, 0.062)
via OA	**0.344 (0.272, 0.417)**	−0.063 (−0.172, 0.051)	−0.022 (−0.062, 0.017)
via LA	**0.224 (0.151, 0.291)**	**−0.088 (−0.165, −0.006)**	**−0.020 (−0.040, −0.002)**
Direct	–	–	**0.203 (0.102, 0.309)**
Total	–	–	**0.182 (0.106, 0.268)**
T2 Survey	**Age → Mediator**	**Mediator → Outcome**	**Age → M → O**
Indirect			
via FA	**0.301 (0.235, 0.367)**	**0.145 (0.047, 0.233)**	**0.044 (0.015, 0.079)**
via PA	**0.486 (0.412, 0.552)**	0.028 (−0.104, 0.165)	0.014 (−0.049, 0.081)
via OA	**0.344 (0.272, 0.417)**	−0.050 (−0.183, 0.120)	−0.017 (−0.065, 0.039)
via LA	**0.224 (0.151, 0.291)**	−0.057 (−0.158, 0.055)	−0.013 (−0.039, 0.010)
via RTW T1	**0.182 (0.106, 0.268)**	**0.480 (0.360, 0.575)**	**0.087 (0.048, 0.135)**
Direct	–	–	0.022 (−0.103, 0.144)
Total	–	–	**0.137 (0.036, 0.245)**
T3 Survey	**Age → Mediator**	**Mediator → Outcome**	**Age → M → O**
Indirect			
via FA	**0.301 (0.235, 0.367)**	−0.036 (−0.131, 0.055)	−0.011 (−0.041, 0.015)
via PA	**0.486 (0.412, 0.552)**	−0.132 (−0.276, 0.000)	−0.064 (−0.137, 0.000)
via OA	**0.344 (0.272, 0.417)**	0.037 (−0.101, 0.198)	0.013 (−0.034, 0.071)
via LA	**0.224 (0.151, 0.291)**	0.083 (−0.027, 0.188)	0.019 (−0.006, 0.045)
via RTW T2	**0.137 (0.036, 0.245)**	**0.781 (0.684, 0.866)**	**0.107 (0.032, 0.202)**
Direct	–	–	0.006 (−0.125, 0.142)
Total	–	–	0.069 (−0.042, 0.188)

[1]Chronological age at time of injury is measured in years.
[2]Non-RTW, return-to-work status based on self-reported survey data, with higher values denoting being off work at follow-up.
[3]FA = functional age index; PA = psychosocial age index; OA = organizational age; LA = life-stage age.
[4]Models adjust for sex, injury type, injury severity, union status, work hours, and pre-injury psychosocial work conditions.

phases of the process where the age-inequalities in RTW may be greatest. Systematic reviews suggest that multi-component interventions may be effective in promoting work participation and RTW among older workers.[11] These interventions may include vocational rehabilitation and claims management activities, such as return-to-work planning, worker education/training or modified work duties[11,30] and could be targeted towards the period of greatest absolute risk to maximize the public-health impact. Yet, studies have shown that older workers may be less likely to receive offers of modified work duties compared to younger workers.[30] Future work should identify specific differences in job or workplace-level contexts across phases of recovery and examine potential targets via intervention and evaluation studies. Finally, the lack of significant differences between older versus younger workers during T2 and T3, as well as the finding that RTW status at follow-up may be driven indirectly by RTW status at T1, suggests that older workers may encounter challenges to recovery if they do not achieve early, safe and sustained RTW.[31]

Objective #3: Mediating role of Age Dimensions

The moderate proportion of the total relationship between chronological age and non-RTW that was mediated via functional and life-stage age suggests that our model was successful in identifying some pathways that may be driving overall age differences in work outcomes. These findings have several important implications. First, functional age and life-stage age may be factors that explain some of the variation in work outcomes across age groups.[32,33] Given the increasing burden of chronic conditions among older individuals in many high-income countries,[1,34] interventions and workplace policies could continue to support injured workers who may require workplace accommodations due to pre-existing chronic conditions or work activity limitations.[35–38] However, the relevance of these factors as important target points for intervention may need to be examined with further studies given the moderate proportion of indirect effects and the finding that functional age only played a role in RTW at later follow-up periods.

Second, it is likely that some of the remaining age differences are due to measurement considerations. In our study, we used the best available measures from survey data that were not explicitly collected to examine age dimensions. If there are effects due to age dimensions that are not well captured using the available indicators, then these effects also would be captured in the residual direct effect in our models.[39] For example, other life stage factors such as spousal retirement, household dependents and caregiving responsibilities may play a role in influencing labour market and work outcomes.[7,40] As noted above, the collection of better data on age dimensions using validated scales[12,13,15,29] may help to address some of these measurement limitations.

Third, the large proportion of the total relationship that was unexplained by our path model suggests that non-age-related factors (rather than age per se) could be driving the relationship between older age and non-RTW. These remaining differences in non-age factors are currently captured in the residual direct effect in our models[39] and could be the subject of future research. For example, offers of modified duties or workplace interactions might play a key role in understanding why younger workers may have a greater likelihood of returning to work compared to older workers.[11,30] Differences in claim processing times during the initial period of recovery also might exacerbate age differences in work outcomes, given that processing times (and thus the total disability duration window) may be shorter among younger versus older workers.[41] On the other hand, positive claim experiences might buffer the negative effect of other mediators,[42] given that claim experiences may be rated more positively among older versus younger workers.

Finally, the remaining direct effects suggest that chronological age continues to serve as an important index variable that encodes both direct effects of chronological age, as well as any residual indirect effects captured along with the direct effect.[43] For example, retirement eligibility is defined by chronological age thresholds even though there may be differences in underlying health status or organizational tenure.[13] Definitions of older versus younger workers also are based on chronological age, typically using cut-points of 55 or 65 years of age.[44] This structuring of society around age may lead to important differences in work and health outcomes at the individual level that persist even after accounting for underlying age related differences.[43]

Strengths and Limitations

Our study findings should be interpreted in relation to the following strengths and limitations. Although data on RTW outcomes were collected prospectively across three follow-up waves, we did not have access to follow-up data on age dimension items beyond their baseline measurement. This would have enabled the testing of a fully longitudinal path model.[26] As our study data were collected from a sample of workers' compensation claimants who met a certain threshold for duration of work-disability, our findings may not generalize to other jurisdictions or less severe injury types.[4]

Our study also has a number of strengths, including the prospective collection of self-reported survey data and measurement of RTW outcomes across multiple waves of follow-up. Although confounding remains an issue with observational studies, our regression and path models controlled for several characteristics that are not typically included in administrative data studies or general population surveys, such as self-reported injury severity and psychosocial work conditions.[3,4,45,46] Our analyses also examine multiple age dimensions simultaneously in a single model to address concerns about competing pathways across each dimension.[13,14]

CONCLUSIONS

Our study demonstrated an approach that could be used to create indices of functional, psychosocial, organizational and life-stage age based on available survey measures. Given the moderate proportion of the age—RTW relationship that was accounted for by RTW status at previous time points and age-related dimensions, our findings underscore the importance of moving beyond simple definitions of age based on chronological years, to more complex conceptual and analytical models that recognize that aging is a multidimensional construct. However, the remaining direct effects suggests that there are additional non-age-related factors and/or measurement considerations that need to be addressed within future research studies, as well as limitations in using secondary data to measure age dimensions. Future research should continue to incorporate better measures of the multidimensionality of age, followed by the use of appropriate analytic techniques that allow for a balanced understanding of age differences across time and underlying mechanisms.

REFERENCES

1. Smith P, Bielecky A, Ibrahim S, et al. Impact of pre-existing chronic conditions on age differences in sickness absence after a musculoskeletal work injury: a path analysis approach. *Scand J Work Environ Health*. 2014;40:167–175.
2. Berecki-Gisolf J, Clay FJ, Collie A, McClure RJ. Predictors of sustained return to work after work-related injury or disease: insights from workers' compensation claims records. *J Occup Rehabil*. 2012;22:283–291.
3. Cancelliere C, Donovan J, Stochkendahl MJ, et al. Factors affecting return to work after injury or illness: best evidence synthesis of systematic reviews. *Chiropr Man Ther*. 2016;24:32.
4. Fan JK, Black O, Smith PM. Examining age differences in duration of wage-replacement by injury characteristics. *Occup Med*. 2016;66:698–705.
5. Besen E, Young AE, Pransky G. Exploring the relationship between age and tenure with length of disability. *Am J Ind Med*. 2015;58:974–987.
6. Pransky GS, Benjamin KL, Savageau JA, Currivan D, Fletcher K. Outcomes in work-related injuries: a comparison of older and younger workers. *Am J Ind Med*. 2005;47:104–112.
7. Krause N, Frank JW, Dasinger LK, Sullivan TJ, Sinclair SJ. Determinants of duration of disability and return-to-work after work-related injury and illness: challenges for future research. *Am J Ind Med*. 2001;40:464–484.
8. Young AE, Wasiak R, Roessler RT, McPherson KM, Anema JR, van Poppel MNM. Return-to-work outcomes following work disability: stakeholder motivations, interests and concerns. *J Occup Rehabil*. 2005;15:543–556.
9. Galizzi M, Leombruni R, Pacelli L, Bena A. Injured workers and their return to work: Beyond individual disability and economic incentives. *Evidence-based HRM*. 2016;4:2–29.
10. Macpherson RA, Lane TJ, Collie A, McLeod CB. Age, sex, and the changing disability burden of compensated work-related musculoskeletal disorders in Canada and Australia. *BMC Public Health*. 2018;18:1–11.
11. Steenstra I, Cullen K, Irvin E, et al. A systematic review of interventions to promote work participation in older workers. *J Safety Res*. 2017;60:93–102.
12. Sterns H, Doverspike D. Aging and the retraining and learning process in organizations. In: Goldstein I, editor. *Training and Development in Work Organizations*. San Francisco, CA: Jossey-Bass; 1989. p. 299–332.
13. Kooij D, de Lange A, Jansen P, Dikkers J. Older workers' motivation to continue to work: five meanings of age: a conceptual review. *J Manag Psychol*. 2008;23:364–394.
14. Spedale S. Deconstructing the 'older worker': Exploring the complexities of subject positioning at the intersection of multiple discourses. *Organization*. 2019;26:38–54.
15. Gendron TL, Inker J, Welleford A. ''How old do you feel'' the difficulties and ethics of operationalizing subjective age. *Gerontologist*. 2018;58:618–624.
16. Shaw WS, Linton SJ, Pransky G. Reducing sickness absence from work due to low back pain: How well do intervention strategies match modifiable risk factors? *J Occup Rehabil*. 2006;16:591–605.
17. Smith PM, Koehoorn M. Measuring gender when you don't have a gender measure: constructing a gender index using survey data. *Int J Equity Health*. 2016;15:82.
18. VanderWeele T, Robinson WR. On causal interpretation of race in regressions adjusting for confounding and mediating variables. *Epidemiology*. 2014;25:473–484.
19. Ng TWH, Feldman DC. Evaluating six common stereotypes about older workers with meta-analytical data. *Pers Psychol*. 2012;65:821–858.
20. Posthuma RA, Campion MA. Age stereotypes in the workplace: common stereotypes, moderators, and future research directions. *J Manage*. 2009;35:158–188.
21. Kenny GP, Yardley JE, Martineau L, Jay O. Physical work capacity in older adults: implications for the aging worker. *Am J Ind Med*. 2008;51:610–625.
22. Kotter-Gruhn D, Kornadt AE, Stephan Y. Looking beyond chronological age: current knowledge and future directions in the study of subjective age. *Gerontology*. 2016;62:86–93.
23. Dimitriadis C, LaMontagne AD, Lilley R, Hogg-Johnson S, Sim M, Smith P. Cohort profile: workers' compensation in a changing Australian labour market: the return to work (RTW) study. *BMJ Open*. 2017;7:e016366.
24. Cadiz DM, Brady G, Rineer JR, Truxillo DM. A review and synthesis of the work ability literature. *Work Aging Retire*. 2019;5:114–138.
25. Schisterman E, Cole S, Platt R. Overadjustment bias and unnecessary adjustment in epidemiologic studies. *Epidemiology*. 2009;20:488–495.
26. Cole DA, Maxwell SE. Testing mediational models with longitudinal data: questions and tips in the use of structural equation modeling. *J Abnorm Psychol*. 2003;112:558–577.
27. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Model*. 1999;6:1–55.
28. MacKinnon D, Krull J, Lockwood C. Equivalence of the mediation, confounding and suppression effect. *Prev Sci*. 2000;1:173–181.
29. Rudolph CW, Kunze F, Zacher H. Getting objective about subjective age: introduction to a special issue. *Work Aging Retire*. 2019;5:265–272.

30. Algarni FS, Gross DP, Senthilselvan A, Battié MC. Ageing workers with work-related musculoskeletal injuries. *Occup Med (Lond)*. 2015;65: 229–237.

31. Franche R-L, Cullen K, Clarke J, Irvin E, Sinclair S, Frank J. Workplace-based return-to-work interventions: a systematic review of the quantitative literature. *J Occup Rehabil*. 2005;15:607–631.

32. Conference Board of Canada. *Enabling Healthy and Productive Work Roundtable*. Ottawa, ON; 2015.

33. The National Seniors Council. *Older Workers At Risk of Withdrawing from the Labour Force or Becoming Unemployed: Employers' Views on How to Retain and Attract Older Workers*. Gatineau, Quebec; 2013.

34. Ofori-Asenso R, Chin KL, Curtis AJ, Zomer E, Zoungas S, Liew D. Recent patterns of multimorbidity among older adults in high-income countries. *Popul Health Manag*. 2019;22:127–137.

35. Gignac MAMM, Kristman V, Smith PM, et al. Are there differences in workplace accommodation needs, use and unmet needs among older workers with arthritis, diabetes and no chronic conditions? Examining the role of health and work context. *Work Aging Retire*. 2018;4:381–398.

36. Vanajan A, Bültmann U, Henkens K. Health-related work limitations among older workers—the role of flexible work arrangements and organizational climate. *Gerontologist*. 2019;60:450–459.

37. White C, Green RA, Ferguson S, et al. The influence of social support and social integration factors on return to work outcomes for individuals with work-related injuries: a systematic review. *J Occup Rehabil*. 2019;29: 636–659.

38. Wilson DM, Errasti-Ibarrondo B, Low G, et al. Identifying contemporary early retirement factors and strategies to encourage and enable longer working lives: a scoping review. *Int J Older People Nurs*. 2020;(February):1–17.

39. VanderWeele TJ. Mediation analysis with multiple versions of the mediator. *Epidemiology*. 2012;23:454–463.

40. Topa G, Depolo M, Alcover CM. Early retirement: a meta-analysis of its antecedent and subsequent correlates. *Front Psychol*. 2018;8:1–24.

41. Gray SE, Lane TJ, Sheehan L, Collie A. Association between workers' compensation claim processing times and work disability duration: analysis of population level claims data. *Health Policy (New York)*. 2019;123:982–991.

42. Collie A, Sheehan L, Lane TJ, Gray S, Grant G. Injured worker experiences of insurance claim processes and return to work: a national, cross-sectional study. *BMC Public Health*. 2019;19:1–12.

43. Settersten RA, Mayer KU. The measurement of age, age structuring, and the life course. *Annu Rev Sociol*. 1997;23:233–261.

44. McCarthy J, Heraty N, Cross C, Cleveland JN. Who is considered an ''older worker''? Extending our conceptualisation of ''older'' from an organisational decision maker perspective. *Hum Resour Manag J*. 2014;24:374–393.

45. Dasinger L, Krause N, Deegan L, Brand R, Rudolph L. Physical workplace factors and return to work after compensated low back injury: a disability phase-specific analysis. *J Occup Environ Med*. 2000;42:323–333.

46. Krause N, Dasinger LK, Deegan LJ, Rudolph L, Brand RJ. Psychosocial job factors and return-to-work after compensated low back injury: a disability phase-specific analysis. *Am J Ind Med*. 2001;40:374–392.