Stiller *et al. J Labour Market Res* (2023) 57:12
https://doi.org/10.1186/s12651-023-00339-6

Journal for Labour Market Research

ORIGINAL ARTICLE

Open Access

Job quality continuity and change in later working life and the mediating role of mental and physical health on employment participation

Michael Stiller*, Melanie Ebener and Hans Martin Hasselhorn

Abstract

In times of demographic change, better job quality is needed to promote health and thereby extend employment participation among older workers. Past research has focussed on the investigation of single job quality characteristics, but neglected their combined effects on health and employment. To address this limitation, we have built upon an established typology based on nine job quality characteristics and representing five profiles of overall poor or good job quality constellations among manual and non-manual older workers, respectively. It was investigated how constant and changing job quality affects non-employment and how mental and physical health mediate this association. Analyses were based on representative data from $N = 2{,}952$ employees born in 1959 or 1965, who participated in all current waves (in the years 2011, 2014 and 2018) of the German lidA cohort study. Job quality was measured in 2011 and 2014 according to profile assignment per wave, composite mental and physical health scores from 2014 were used as mediators and non-employment (vs. employment) in 2018 represented the outcome. Two separate mediation models were calculated, one for manuals and one for non-manuals. Among manuals with constantly poor job quality, the risk of non-employment was increased through both poor mental and physical health. Deteriorating job quality increased this risk through poor mental health, while changing from manual to non-manual work reduced this risk through better physical health. Among non-manuals, poor job quality was not related to the risk of non-employment and no health effects were found to significantly mediate such a risk. In conclusion, the health risks of poor later-life job quality demand critical consideration to maintain employability, particularly of manual workers in poor quality jobs. Timely workplace improvements for certain groups are needed to increase employment participation in good health, thereby increasing efficiency and fairness of measures promoting longer working lives.

Keywords Job quality, Working conditions, Physical health, Mental health, Employment participation, Extended working life, Older worker, Mediation analysis, Prospective cohort study

JEL Classification J260, J810

*Correspondence:
Michael Stiller
arbwiss@uni-wuppertal.de
Department of Occupational Health Science, University of Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany

1 Introduction

Accelerated population ageing confronts the German society with shrinking numbers of social security contributors (The Organisation for Economic Co-Operation and Development [OECD] 2019), while most older employees continue to leave the labour market several years before statutory retirement age (OECD 2018). Consequently, policymakers are aiming to extend working lives by, for example, introducing a gradual increase of the pensionable age (Romeu-Gordo and Sarter 2020) and by promoting better working conditions (OECD 2018). Between 2009 and 2019, employment rates in Germany have increased substantially for the age groups 55–59 and 60–64 years (Federal Office of Statistics 2022), yet many of these older workers report limitations in health (Varekamp et al. 2013), and their number continues to increase (Hasselhorn and Müller 2021). Given that extended working lives will affect large parts of the workforce in the near future, it has become necessary to critically consider job quality and individual work capacity as a precondition for more years in work in good health, in order to assure both fairness and effectiveness of future retirement regulation (Hasselhorn 2020; Ní Léime et al. 2020; Phillipson 2019). Therefore, two questions appear to be relevant in this context: how does job quality affect health among older workers in Germany and how do these health consequences affect their employment participation in the last working years. For this purpose, a scientific investigation of the respective underlying mechanisms is needed, which requires a sound concept of job quality and a differentiated consideration of health.

1.1 Job quality in later working life

The concept of job quality has been discussed among many scientific disciplines with different emphasis in the consideration of its physical, psychological and socio-economic consequences for the individual worker (Achatz and Gundert 2017). This has resulted in the development of different indicators for its measurement varying by content, number and weighting of the underlying predictors (Muñoz de Bustillo et al. 2009). Job quality indicators reflecting observable characteristics of work and employment are understood as `objective´ indicators, while subjective indicators explicitly consider individual preferences and expectations of the employee in this context (Achatz and Gundert 2017). By now, academics agree that job quality is a multidimensional concept (e.g. European Foundation for the Improvement of Living and Working Conditions [Eurofound] 2016; Muñoz de Bustillo et al. 2009), because a number of distinct work-related dimensions such as earnings, employment security, learning and development opportunities, autonomy, work intensity, the physical and social work environment and working time have been shown to be of high relevance for the workers´ health and well-being (Achatz and Gundert 2017; Eurofound 2016). When researching job quality from an occupational health perspective—as in the present study—the focus lies particularly on objective job characteristics describing the work content and organisational framework conditions as well as their potential impact on health and employment (Schlick et al. 2018). This understanding "capture[s] how workers perform their work and under what conditions. The job level is of particular significance, as it is the level at which the contractual relationship between employers and employees is set; it is also the unit of design and implementation of many regulations devised by governments and social partners. In addition, a person's job determines their task set as well as their practical experience of work" (Eurofound 2016, p. 36).

When it comes to the investigation of job quality in research, spanning the past decades and across most disciplines, the dominant methodological approach to the empirical assessment of the relationship between work quality exposure and an outcome is the so-called *variable-centred* analysis approach (Howard and Hoffman 2017). There, a single work factor—such as heavy lifting—denotes the *variable* which is related to an outcome, for example, the occurrence of low back pain. In occupational health research, this approach may be relevant for identifying single occupational risk factors for well-being and health (e.g. Burns et al. 2016; Mäcken 2019; Welsh et al. 2016). The occupational epidemiologist Niedhammer and colleagues (2021) have summarised empirical findings based on the variable-centred analysis approach in a meta-analysis covering studies from 2000 to 2020, where the association between specific job quality characteristics (single *variables*) and health outcomes has been demonstrated.

The variable-centred approach cannot, however, portray a worker's full working situation in terms of multidimensional job quality exposure (Eurofound 2016; Muñoz de Bustillo et al. 2009). This multidimensional picture of work quality, however, may be relevant in research and policy, where the aim is to describe and understand the overall work situation in the form of states, trends and trajectories of distinct occupational groups. Thus, occupational epidemiology has in recent years begun to statistically identify prototypical constellations of a range of physical, psychosocial and organisational work exposures in working populations to define and capture overall job quality (Bujacz et al. 2018, 2021; Carr et al. 2021; Eurofound 2016; Lowe 2007; van Aerden et al. 2015; Vanroelen et al. 2010). In doing so, these studies follow the so-called *person-centred* analysis approach, where—unlike the variable-centred approach—the conceptual focus lies on a broad set of a worker's work

characteristics. Such an analysis approach appears to be suitable for the investigation of older working populations in particular, as it has been emphasised by life-span and accumulation theorists, that life-long selection processes may form and consolidate group patterns in the working population (Amick et al. 2016; Dannefer 2003).

Taking into account that multiple working conditions also affect the retirement transition (Scharn et al. 2018), and that the relevance of certain job quality characteristics may vary between countries and age groups (Achatz and Gundert 2017; Eurofound 2016), this person-centred approach was applied recently among baby-boomers in Germany to obtain a nationally representative typology that allows for the investigation of overall job quality among older workers approaching retirement age (Hasselhorn et al. 2020). A total of five profiles emerged (Hasselhorn et al. 2020). The profiles have the advantage of depicting a constellation of relevant job quality dimensions, where favourable manifestations of certain dimensions may compensate for adverse manifestations of other ones. This allows for a relative evaluation of the work environment of specific groups of older workers and for a comprehensive job quality monitoring in the last working years, including the investigation of cumulative and change effects in the working population. Further, the profiles "should provide policymakers with a comprehensive input for targeted policies aimed at addressing and improving job quality" (Eurofound 2016, p. 128).

Thus, to summarise, comprehensive profiles as mentioned above allow for the in-depth investigation of combined job quality effects in terms of health risks and potentials for later-life employment participation.

1.2 The mediating role of health

The well-established pathway of poor quality work leading to early exit from employment is mostly investigated by means of ill-health exit routes such as long-term sickness absence (d´Errico et al. 2021) and disability retirement (Knardahl et al. 2017; Schram et al. 2020; Söderberg et al. 2021; van Zon et al. 2022). Interestingly, most studies implicitly address a health-mediation, without explicitly testing for their assumption. However, if the policy conclusion from such studies is to invest in the health of the older working population, then a differentiated understanding of this pathway is needed. Here, a promising approach may be to follow the early exit pathway by explicitly testing for a health-mediation. There is evidence for both direct paths: the path of job quality predicting health and the path of health predicting early exit from work.

The association of job quality with health has been investigated extensively in the epidemiological literature, and causally demonstrated for physical (Bernard 1997; Mayer et al. 2012; Pega et al. 2022) and psychosocial work exposures (Bernard 1997; Niedhammer and colleagues 2021; Theorell et al. 2015). In his review, Bernard (1997) summarised evidence from studies between 1936 and 1997, and identified common physical workplace factors that cause selected musculoskeletal disorders. Mayer et al. (2012) provided updated evidence in their systematic review covering the years 1975–2009, highlighting the negative effects of physical work exposures for shoulder/neck problems. Today, physical risk factors are globally monitored to assess their health consequences for the workforce (Pega et al. 2022). Regarding psychosocial working conditions, a recent meta-analysis by Niedhammer and colleagues (2021) on studies from 2000 to 2020 found many such workplace factors to affect a broad range of physical and mental health outcomes, thus confirming findings from previous decades (c.f. Bernard 1997; Theorell et al. 2015). In conclusion, there is well established evidence for the direct path of job quality predicting health.

Multiple reviews of longitudinal studies confirm that poor health is a strong predictor of early exit from work (Scharn et al. 2018; van den Berg et al. 2010a; van Rijn et al. 2014). The term health, however, represents many concepts which can be operationalised and measured in many ways (Medin and Alexanderson 2000). Based on own evidence, Wikman et al. (2005) emphasise that in public health research different health concepts should not be regarded as interchangeable alternatives. Indeed, several studies indicate differences in the magnitude of the effects when comparing the different health indicators and their impact on early exit from work (de Breij et al. 2020; van den Berg et al. 2010b; van Rijn et al. 2014). Moreover, in a recent discussion paper on the differentiated role of health in the work-retirement transition, Hasselhorn et al. (2022) also add that the choice of the work exit outcome may influence the strength of the relation of poor health with early exit.

In consequence, evidence on the association of job quality with health, as well as health with exit from employment varies by the indicators chosen.

To our knowledge, only one study directly investigated the health-mediated association of specific working conditions (work control and effort-reward imbalance [ERI]) with retirement age (Mäcken 2019). Among 302 workers aged 50–65 years, both low work control and poor self-rated health reduced retirement age directly across two time points (in 2004–2014), and direct effects of single working conditions on physical health and depressive symptoms emerged. However, in neither case was the work-retirement association mediated by health (Mäcken 2019). A strength of the study is that three potential health mediators were investigated. However, this was done in separate mediation models, which prevents evaluation of the mediating role of one specific health component in the presence of further health components. A

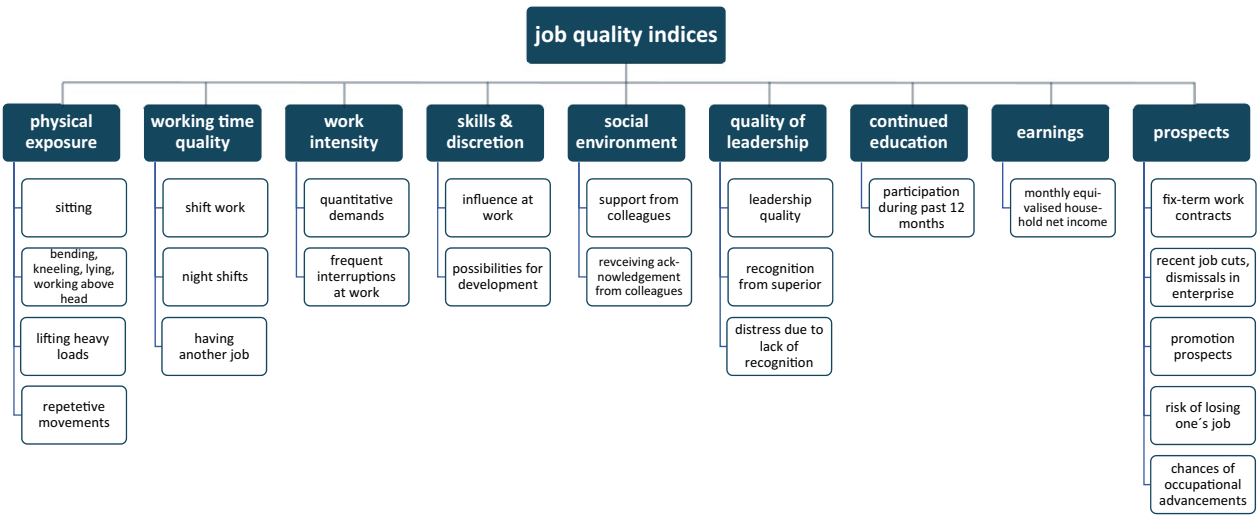

Fig. 1 Content and composition of job quality indices in the present study (established by Hasselhorn et al. 2020)

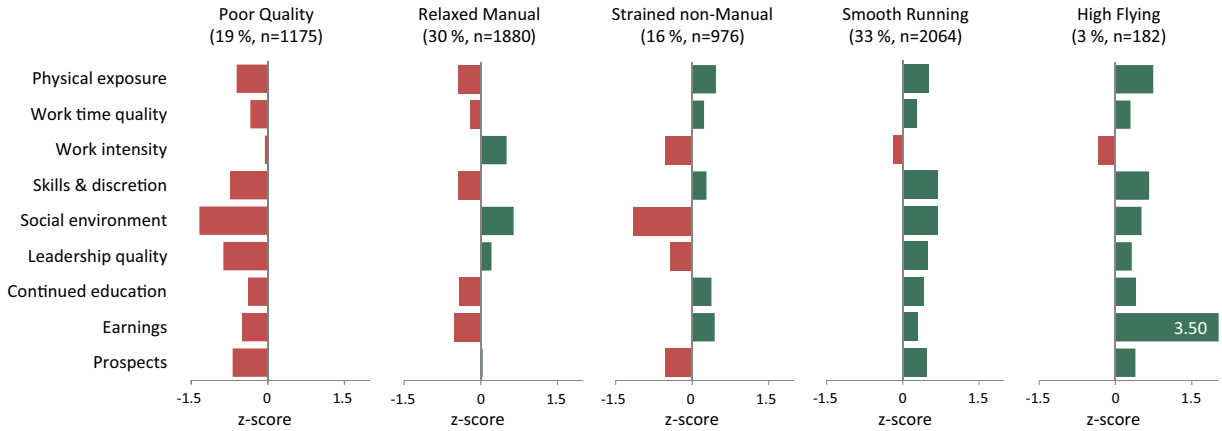

Fig. 2 Distribution of job quality profiles among older employees in Germany (n = 6,277; 2011 data). Red = adverse manifestation, green = favourable manifestation; the earnings bar of the High Flying profile is shortened and the numerical z-score (= 3.50) displayed (adapted from Hasselhorn et al. 2020)

further shortcoming of the study is that only two work factors were included and that their change was not considered. From a prevention perspective, investigating job quality change may allow to estimate the interventional potential of job quality measures, as physical and mental health can be affected differently by changing work exposure and each health component requires different preventive approaches (Baxter et al. 2021). In conclusion, it might be particularly important to consider change of job quality and to differentiate between mental and physical health in the same analysis.

1.3 Purpose of the present study

To summarise, the health-mediation of job quality effects on employment participation has been implicitly assumed so far, but requires an explicit investigation that considers different health components concurrently. Moreover, the concept of job quality applied should cover the variety of work exposure constellations of the working population under investigation. Therefore, the main aim of the present study is to simultaneously assess continuity and change effects of typical constellations of working conditions (representing job quality as in Figs. 1, 2) on employment participation in the pre-retirement years, mediated through both mental and physical health. In doing so, we assume that constant poor job quality will show a health-mediated risk of non-employment, as implied by previous studies (d'Errico et al. 2021; Knardahl et al. 2017; Robroek et al. 2013; Schram et al. 2020; Söderberg et al. 2021; van Zon et al. 2022). While, to date, little is known on change effects when considering job quality as outlined

Table 1 Sociodemographic characteristics of the lidA sample per assessment and in the final study sample

		2011 (N = 6,585)		2014 (N = 4,244)		2018 (N = 3,586)		final sample (n = 2,952)	
		n	(%)	n	(%)	n	(%)	n	(%)
Cohort									
	1959	2,908	(44.2)	1,922	(45.3)	1,624	(45.4)	1,353	(45.8)
	1965	3,677	(55.8)	2,322	(54.7)	1,956	(54.6)	1,599	(54.2)
Sex									
	male	3,063	(46.5)	1,915	(45.1)	1,610	(45.0)	1,328	(45.0)
	female	3,522	(53.5)	2,329	(54.9)	1,970	(55.0)	1,624	(55.0)
Educational level									
	low	1,709	(26.2)	952	(22.6)	777	(21.9)	608	(20.7)
	medium	3,499	(53.6)	2,358	(56.0)	2,001	(56.3)	1,671	(56.9)
	high	1,319	(20.2)	904	(21.5)	778	(21.9)	657	(22.4)
Employment status									
	employed	6,278	(95.3)	3,976	(93.7)	3,251	(91.5)	2,809	(95.2)
	not employed	307	(4.7)	268	(6.3)	303	(8.5)	143	(4.8)

above in the older working population in Germany, a further study aim was to explore potential health-mediated effects of job quality change.

2 Methods

2.1 Study design and sampling

Data from the `leben in der Arbeit` (lidA) cohort study on work, age, health and employment (www.lida-studie.de) was used. lidA is a prospective cohort study focussing on the transition from work to retirement in two baby-boomer cohorts in Germany born 1959 or 1965 (Hasselhorn et al. 2014).

The sample was selected as follows: Prior to data collection, a two-stage random sample was drawn from the "integrated employment biographies" (IEB) dataset, which includes all employees in Germany subject to social security. At the first stage, 222 municipalities were drawn with probabilities proportional to their size and stratified by state and municipal size. At the second stage, a simple random sample was drawn per sample point, covering employees born 1959 or 1965 and subject to social security contributions, thus resulting in a self-weighting and proportional sample representative for the socially insured working population in Germany (excluding self-employed or sworn civil servants) of the respective age cohorts in 2009, when initial sampling took place (see Hasselhorn et al. 2014, p. 1739; Schröder et al. 2013; Steinwede et al. 2015, 2018).

Participants were then surveyed via computer-assisted personal interviews at their homes in 2011 (N = 6,585), 2014 (N = 4,244) and 2018 (N = 3,586). In 2011, the response rate was 27.3% (RR5 according to The American Association for Public Opinion Research [AAPOR]) and the cooperation rate (COOP3) was 32.6% (The American Association for Public Opinion Research 2016), which is similar to that of comparable studies in Germany (e.g. d'Errico et al. 2021).

In the present study, participants were included if they participated in all three assessment waves and were defined as "employed" in the 2011 and 2014 assessment (see Sect. 2.2.3). This way, the association of job quality change from 2011 to 2014 and employment participation in 2018 can be assessed. This selection reduced the size of the final analysis sample to n = 2,952 (see Table 1).

Frequencies not adding up to total sample size per characteristic are due to missing values. For details on the classification of educational level and employment status, see 2.2 Measures.

2.2 Measures

2.2.1 Job quality profiles

This article builds on the above-mentioned typology of five job quality profiles for employed baby-boomers in Germany by Hasselhorn et al. (2020), who followed the conceptual and methodological approach of the EU-Agency "Eurofound" (2016). Below, the job quality concept and methodology of Eurofound are outlined. Then, the adapted job quality dimensions by Hasselhorn et al. (2020) are described followed by data preparation, the actual statistical profile identification and subsequent profile assignment. After describing basic features of the profiles and its assigned participants, this section closes with a depiction of the coding of the final job quality change groups based on profile assignment.

Eurofound understands job quality as a multidimensional concept comprising seven specific dimensions operationalised with one respective index, that (a) is developed at the job level, (b) is covering job resources and demands, (c) contains observable job features that are related to meeting peoples´ needs from work, and (d) has been shown to have an independent influence on health and well-being (Eurofound 2016, p. 36). More specifically, these job quality dimensions are *physical exposure, work time quality, work intensity, skills and discretion, social environment, earnings* and *prospects*. They were clustered by Eurofound using a finite mixture modelling technique called latent profile analysis (LPA), where five profiles emerged as the most suitable profile solution for the European working population in the depiction of typical constellations of the mentioned job quality dimensions (Eurofound 2016).

Based on lidA data from 2011, Hasselhorn et al. (2020) reconstructed these seven indices in their dataset and added two further dimensions, as they were considered to be of particular relevance for the investigation of the retirement transition of baby-boomers in Germany (see Fig. 1). First, the *continued education* index was added, because so far, extended working lives policies were implemented at the expense of training and skill development opportunities among older workers (Phillipson 2019), thus representing an important job resource (or risk) specifically in countries with low levels of training but high proportions of older workers such as Germany (Carmichael and Ercolani 2014; Conen et al. 2012). Second, the job quality index "social environment" by Eurofound (2016) was split in the two components *leadership quality* and *social work environment*, as the association of low leadership quality with poor health is particularly pronounced among older working age groups regarding mental health (Zoer et al. 2011).

Figure 1 depicts the composition of the job quality indices used by Hasselhorn et al. (2020) for profile building. Except for continued education and earnings, each index comprises specific positive or negative job features in the form of indicators. Prior to index calculation, all indicators were recoded so that high values represent favourable and low values adverse manifestations in accordance with the literature.[1]

Prior to the latent profile analysis and subsequent assignment of participants to the identified profiles, missing values on single indices were inspected in the assessment waves of interest. They were mostly below 1.0%. For the earnings index, however, they were 19.9% in 2011 and 15.9% in 2014, which corresponds to the mean refusal rate in Europe to disclose personal income (c.f. Eurofound 2016). Thus, all missings were imputed using stochastic regression imputation to prevent selection bias and ensure high sample size in a dataset to be used with other statistical programs (Enders 2010). This applied to 22.9% of the sample in the 2011 assessment and 18.3% in 2014. With that dataset, a LPA was performed on data from the 2011 assessment using the software Latent GOLD® 5.1. A five-profile solution emerged as the most suitable and substantially interpretable solution. Based on the model equation obtained from the latent profile model on 2011 data, participants were then assigned to a profile in 2011 and also 2014, based on the highest posterior probability (for profile affiliation) obtained from said equation. Mean highest posterior probabilities across profiles ranged from 0.84 to 0.94 in 2011 and from 0.83 to 0.96 in 2014, indicating reliable classification. Subsequent analyses demonstrated structural stability of the five profile solution and external profile validity concerning the older working population in Germany (Hasselhorn et al. 2020). Profile features and the assigned workers will be characterised in the following for the 2011 assessment (see Fig. 2).

The profiles *Poor Quality* (PQ; 18.7%) and *Relaxed Manuals* (RM; 30.0%) are predominantly manual

[1] The respective indices were calculated as described in the following (weighting indicated in square brackets). The ordinal physical exposure index is the summed up indication of working time spend sitting (0 = no, 1 = yes) [1], bending, kneeling/lying/working above head [1], lifting heavy loads [1] or with repetitive movements (0 = yes, 1 = no, respectively) [1]. Raw sum scores were transformed to range 0–100. The ordinal working time quality index comprised of the summed up indication (0 = yes, 1 = no) of shift work [1], night shifts [1] and having another job [1]. Raw scores were transformed to range 0–100. The metric work intensity index consists of the 4-item Copenhagen Psychosocial Questionnaire (COPSOQ) scale "quantitative demands" [2] and the indication (0 = yes, 1 = no) of frequent interruptions at work [1]. After weighting, both components were summed up and transformed to range 0–100. The metric skills and discretion index was the mean of the two 3-item COPSOQ scales "influence at work" [1] and "possibilities for development" [1], already ranging from 0–100. The metric social environment index comprised the 2-item COPSOQ scale "support from colleagues" [1] with range 0–100 and the dichotomous ERI item "receiving acknowledgement from colleagues" [1], where absence was coded with 0 and presence with 100. The arithmetic mean was computed with range 0–100. The metric quality of leadership index comprised the 3-item COPSOQ scale "quality of leadership" [3] with range 0–100 and the ERI item "distress due to lack of recognition from superior" [1], where presence of recognition was coded with 25. Lack of recognition was coded according to the distress induced, namely "not at all" = 25, "moderate" = 16.67, "strong" = 8.33 and "very strong" = 0, respectively. The COPSOQ scale was multiplied with 0.75 to achieve the intended triple weighting and both components were summed up, resulting in an index with range 0–100. Participation in continued education in the last 12 months was a dichotomous item (0 = no and 1 = yes). The metric earnings index was calculated as the monthly equivalised household net income. The ordinal prospects index was the summed up indication of fixed-term work contract [1], recent job cuts/dismissals in enterprise [1], risk of losing one´s job [1], promotion prospects [1] and chances for occupational advancement (0 = yes, 1 = no, respectively) [1]. Raw sum scores were transformed to range 0–100. In the final latent profile analysis, the mixed measurement levels per index were specified accordingly.

profiles. Workers in PQ are adversely exposed to all job quality dimensions included. In contrast, workers in RM have favourable work intensity and social resources (c.f. Fig. 2). Importantly, older workers to whom those two profiles apply do not differ with respect to sociodemographic characteristics such as educational level, manual work and task complexity level (Hasselhorn et al. 2020). However, profile validation linking the profiles to work- and health-related outcomes showed that PQ represents an adverse and RM a favourable profile (c.f. Hasselhorn et al. 2020; Stiller et al. 2021). The profiles *Strained non-Manual* (SnM; 15.5%) and *Smooth Running* (SR; 32.9%) are predominantly *non*-manual profiles. Workers in SnM display a complementary job quality constellation to those in RM, while workers in SR are favourably exposed to almost all job quality dimensions. As with the two manual profiles, SnM and SR also share the same sociodemographic characteristics such as higher educational level, non-manual jobs and medium to high task complexity levels. Profile validation showed that SnM represents an adverse and SR a favourable profile. Finally, the profile *High Flying* (HF; 2.9%) displays extremely high earnings, otherwise it resembles the SR profile (Hasselhorn et al. 2020). To summarise, these profiles capture distinct overall job quality in the heterogeneous older workforce in Germany while differentiating between manual and non-manual work at the same time.

For the present analyses, the small HF and the large SR profile were merged as it would otherwise result in $5 \times 5 = 25$ change groups with some group sizes not being eligible for any statistical analyses. Eventhough both profiles were previously shown to be conceptually distinct (c.f. Hasselhorn et al. 2020), they have similar job quality constellations. Thus, merging both profiles additionally facilitates interpretability and consequently reduced the overall complexity of the results (c.f. Stiller et al. 2021). Job quality change from 2011 to 2014 was coded according to the respective profile assignments, yielding $4 \times 4 = 16$ final change groups, eight for initially manual and eight for non-manual workers:

Initially manual change groups (n = 1,323).

- PQ-PQ (− −): adverse (−) manual to adverse (−) manual profile
- PQ-SnM (− −): adverse (−) manual to adverse (−) non-manual profile
- PQ-RM (− +): adverse (−) manual to favourable (+) manual profile
- PQ-SR (− +): adverse (−) manual to favourable (+) non-manual profile
- RM-PQ (+ −): favourable (+) manual to adverse (−) manual profile
- RM-SnM (+ −): favourable (+) manual to adverse (−) non-manual profile
- RM-SR (+ +): favourable (+) manual to favourable (+) non-manual profile
- RM-RM (+ +): favourable (+) manual to favourable (+) manual profile (= reference group)

Initially non-manual change groups (n = 1,629).

- SnM-PQ (− −): adverse (−) non-manual to adverse (−) manual profile
- SnM-SnM (− −): adverse (−) non-manual to adverse (−) non-manual profile
- SnM-RM (− +): adverse (−) non-manual to favourable (+) manual profile
- SnM-SR (− +): adverse (−) non-manual to favourable (+) non-manual profile
- SR-PQ (+ −): favourable (+) non-manual to adverse (−) manual profile
- SR-SnM (+ −): favourable (+) non-manual to adverse (−) non-manual profile
- SR-RM (+ +): favourable (+) non-manual to favourable (+) manual profile
- SR-SR (+ +): favourable (+) non-manual to favourable (+) non-manual profile (= reference group)

2.2.2 Mental and physical health

Health was assessed with the German adaptation of the internationally well-established Short Form Health Survey (SF-12v2; Nübling et al. 2006). The SF-12v2 captures a mental and a physical health component summary across 12 self-report items with three to five ordered response categories. Sum scores per component range from 0 to 100 with higher scores indicating better health.

2.2.3 Non-employment

Non-employment represented the outcome measure and was based on self-reported employment status assessed in 2018. Participants reporting full-time- (≥ 35 h per week), part-time-/marginal employment or participation in a job creation scheme, including those receiving partial disability pension, were classified as employed (coded = 0). Those reporting a qualification measure, unemployment/job search, long-term sick-listed (≥ 6 weeks/medical rehabilitation), other (e.g. homemakers), early retirement or those receiving full disability pension were classified as not employed (coded = 1).

2.2.4 Covariates

In order to describe basic sample characteristics, educational level was assessed by an ordinal 8-point index

combining highest school-leaving qualification and highest vocational training qualification as suggested by Jöckel et al. (1998), and trichotomised for reasons of clarity as follows: the category "low educational level" represented workers with no qualification, vocational operational education or off-the-job training. "Medium educational level" comprised workers with technical and master school, and the category "high educational level" comprised higher vocational education or university education.

To account for potential confounding due to age and sex differences in employment participation in the sample under study (c.f. Table 2), birth cohort (coding: 0 = 1965, 1 = 1959) and sex (0 = male, 1 = female) were included as covariates in the separate mediation models for manuals and non-manuals, respectively (see Fig. 3 for graphical depiction).

2.3 Statistical analyses

Statistical analyses encompassed several steps. First, mean health levels in 2014 and frequencies for non-employment in 2018 were inspected descriptively and odds ratios (OR) with 95% confidence intervals were calculated to assess the direct association of job quality with non-employment, which were tested with binary logistic regression analyses (controlling for cohort and sex). Next, testing for the assumed mediation encompassed two steps. First, we verified basic profile effects for non-employment in 2018 by calculating the mediation model only with profile assignment in 2011 as the exposure, and with mental and physical health in 2014 as parallel (not sequential) mediators as in the final models (controlling for cohort and sex; see Fig. 3). We considered this prior step necessary, in order to demonstrate that (a) the profiles themselves display adverse or favourable overall job quality regardless of the investigated continuity and change effects on health and non-employment in the final analyses, and (b) to be able to compare change effects, as in the final mediation models health and the second profile assignment coincide in 2014. Hereafter, we finally investigated exposure effects of job quality continuity and change, respectively, between 2011 and 2014 on non-employment in 2018, again, with mental and physical health in 2014 as parallel mediators and controlling for cohort and sex (see Fig. 3). Due to different scaling of the mediator and the outcome measures, ordinary least square regression models were fitted for mental and physical health and unstandardised regression coefficients B with 95% confidence intervals were reported. In contrast, binary logistic regression models were fitted for non-employment as the outcome and OR with 95% confidence intervals were reported.

Indirect effects were calculated using the "product method" following Rijnhart et al. (2019) and their statistical significance was assessed with 95% percentile bootstrap confidence intervals (10,000 draws). When applying the product method (also: product-of-coefficients method) two regressions are employed. In the first one, the mediators are regressed on the exposure variable and covariates. In the second one, the outcome is regressed on the exposure variable, both mediators and the covariates. The indirect exposure effect on the outcome is then taken as the product of the effect of the exposure on the respective mediator times the effect of the respective mediator on the outcome, which is the preferred indirect effect estimator for models with a continuous mediator and a binary outcome (Rijnhart et al. 2019).

To account for attrition between the three assessment waves, additional sensitivity analyses were performed afterwards as described in the following: a potential selection bias was checked concerning attrition in job quality profiles between 2011 and 2014, and tested with binary logistic regressions (coding of dependent variable: 0 = participation in 2014, 1 = attrition between 2011 and 2014). In addition, and to check for a potential health bias due to attrition across profiles between 2011 and 2014, mean mental and physical health levels as the dependent variables were compared across assignment to one of the final four job quality profiles in 2011 (PQ/RM/SnM/SR) and participation status in 2014 (yes/no) using a two-way analysis of variances.

All mediation analyses were performed using the PROCESS Macro 4.0 for SPSS (Hayes 2017), the remaining analyses were done using IBM SPSS Statistics 27®.

3 3. Results

3.1 Descriptive statistics

Of the participants, 52.4% remained in or changed between favourable job quality profiles (RM-RM, SR-SR, RM-SR, SR-RM; Table 2). For adverse profiles, this was 18.9% (PQ-PQ, SnM-SnM, PQ-SnM, SnM-PQ). A change from adverse to favourable job quality applied to 14.6% of the workers (PQ-RM, PQ-SR, SnM-RM, SnM-SR) and 14.4% changed from favourable to adverse job quality (RM-PQ, RM-SnM, SR-PQ, SR-SnM). Groups with changes from manual to non-manual profiles and vice versa, comprised 11.9% and 10.1% of the sample.

Regarding initially manuals, mental health was lowest when staying in adverse profiles and highest for those in constantly favourable profiles or when changing to non-manual favourable profiles (Table 2). Physical health was lowest when staying in the adverse profile and highest among those changing from favourable manual to non-manual profiles. Significant associations were observed

Table 2 Descriptive statistics for job quality change groups from 2011 to 2014, health levels in 2014 and non-employment in 2018

	n	% of N	Health levels in 2014				Employed in 2018				OR[a]	[95% CI]
			mental		physical		yes		no			
			M	(SD)	M	(SD)	n	(%)	n	(%)		
Cohort												
1959	1,353	45.8	50.9	(10.5)	48.9	(9.2)	1,268	(93.7)	85	(6.3)		
1965	1,599	54.2	50.1	(9.9)	50.5	(8.7)	1,541	(96.4)	58	(3.6)		
Sex												
Male	1,328	44.9	51.6	(9.6)	50.3	(8.7)	1,272	(95.8)	56	(4.2)		
Female	1,624	55.1	49.5	(10.5)	49.4	(9.2)	1,537	(94.6)	87	(5.4)		
Job quality groups:												
Initially manual												
PQ-PQ (− −)	228	7.7	46.1	(11.2)	45.8	(9.3)	200	(87.7)	28	(12.3)	**2.46**	**[1.39; 4.34]**
PQ-SnM (− −)	74	2.5	47.1	(10.6)	48.2	(9.0)	71	(95.9)	3	(4.1)	0.70	[0.20; 2.37]
PQ-RM (− +)	164	5.6	50.7	(9.2)	47.5	(8.7)	156	(95.1)	8	(4.9)	0.86	[0.38; 1.95]
PQ-SR (− +)	45	1.5	52.5	(9.9)	48.4	(7.2)	42	(93.3)	3	(6.7)	1.28	[0.37; 4.45]
RM-PQ (+ −)	130	4.4	48.1	(9.8)	47.4	(9.4)	116	(89.2)	14	(10.8)	**2.04**	**[1.03; 4.06]**
RM-SnM (+ −)	60	2.0	48.3	(11.5)	50.5	(9.4)	[b]	[b]	[b]	[b]	0.56	[0.13; 2.43]
RM-SR (+ +)	175	5.9	52.4	(9.5)	51.3	(8.4)	171	(97.7)	4	(2.3)	0.39	[0.14; 1.15]
RM-RM (+ +)	447	15.1	52.5	(8.7)	48.1	(8.7)	422	(94.4)	25	(5.6)	(ref)	
Initially non-manual												
SnM-PQ (− −)	63	2.1	43.9	(10.7)	46.5	(10.2)	59	(93.7)	4	(6.3)	1.77	[0.59; 5.26]
SnM-SnM (− −)	198	6.6	47.2	(10.4)	50.7	(9.0)	194	(98.0)	4	(2.0)	0.56	[0.19; 1.62]
SnM-RM (− +)	56	1.9	50.6	(11.8)	48.9	(8.6)	51	(91.1)	5	(8.9)	2.54	[0.94; 6.91]
SnM-SR (− +)	166	5.6	51.0	(9.1)	52.1	(8.2)	162	(97.6)	4	(2.4)	0.66	[0.23; 1.90]
SR-PQ (+ −)	40	1.4	46.7	(11.2)	47.8	(10.3)	[b]	[b]	[b]	[b]	1.24	[0.28; 5.44]
SR-SnM (+ −)	194	6.6	48.2	(11.0)	51.8	(8.5)	188	(96.9)	6	(3.1)	0.84	[0.34; 2.06]
SR-RM (+ +)	139	4.7	51.4	(10.1)	49.5	(9.3)	136	(97.8)	3	(2.2)	0.62	[0.19; 2.08]
SR-SR (+ +)	773	26.7	52.7	(9.5)	52.0	(8.4)	745	(96.4)	28	(3.6)	(ref)	

Note. N = 2,952; OR = odds ratio; 95% CI = 95% confidence interval; ref = reference category; [a] separate logistic regression models for manual and non-manual change groups, respectively, and adjusted for cohort and sex (significant OR at $p < 0.05$ in bold); [b] exact frequency with $n < 3$ cannot be displayed for reasons of legal data protection; PQ-PQ = Poor Quality 2011 + 2014, PQ-RM = Poor Quality 2011/Relaxed Manual 2014, PQ-SnM = Poor Quality 2011/Strained non-Manual 2014, PQ-SR = Poor Quality 2011/Smooth Running 2014, RM-PQ = Relaxed Manual 2011/Poor Quality 2014, RM-RM = Relaxed Manual 2011 + 2014, RM-SnM = Relaxed Manual 2011/Strained non-Manual 2014, RM-SR = Relaxed Manual 2011/Smooth Running 2014; SnM-PQ = Strained non-Manual 2011/Poor Quality 2014, SnM-RM = Strained non-Manual 2011/Relaxed Manual 2014, SnM-SnM = Strained non-Manual 2011 + 2014, SnM-SR = Strained non-Manual 2011/Smooth Running 2014, SR-PQ = Smooth Running 2011/Poor Quality 2014, SR-RM = Smooth Running 2011/Relaxed Manual 2014, SR-SnM = Smooth Running 2011/Strained non-Manual 2014, SR-SR = Smooth Running 2011 + 2014; (− −) denotes adverse job quality in 2011 and 2014, (− +) adverse job quality in 2011 and favourable quality in 2014, (+ −) favourable quality in 2011 and adverse quality in 2014, and (+ +) favourable job quality in 2011 and 2014.

for groups with the highest frequency of non-employment in 2018, namely manuals in constant adverse job quality (12.3%; OR = 2.46, 95% CI [1.39; 4.34]) or when changing to the adverse profile (10.8%; OR = 2.04, 95% CI [1.03; 4.06]). Non-employment was least frequent when changing from the favourable manual to the non-manual profile (2.3%).

A similar pattern emerged for initially non-manuals (Table 2). Here, mental health was lowest when changing from the adverse profile to the corresponding adverse manual profile and highest when staying in or changing to favourable profiles. Physical health was lowest when changing to the adverse manual profile and highest when staying in non-manual profiles. Among those changing from the adverse to manual profiles, non-employment was somewhat more frequent (6.3% and 8.9%).

3.2 Mediation analyses of job quality effects

Prior to the final mediation analyses, health-mediation of job quality in 2011 on non-employment in 2018 was tested to verify adversity and favourability of the profiles and to establish a causal relationship with consecutive non-employment. Compared to the favourable non-manual profile (SR), the adverse manual profile was directly associated with an increased risk of non-employment seven years later (PQ: OR = 1.88, 95% CI

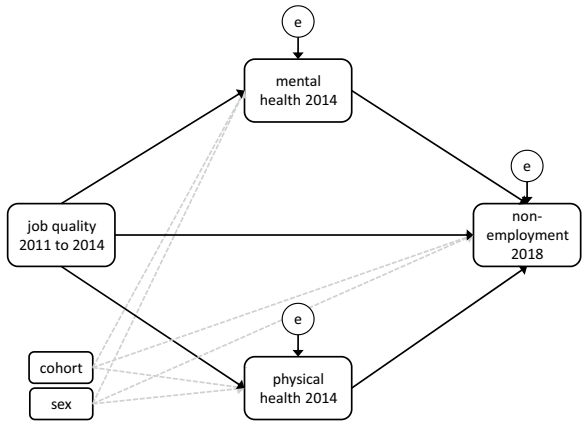

Fig. 3 Parallel mediation models for job quality effects on non-employment. The models are separated for the respective manual and non-manual change groups according to their profile assignment in 2011 and 2014

[1.18; 3.00]; Table 3). Regarding indirect effects, both adverse profiles were significantly associated with an increased risk of non-employment mediated through lower mental health (PQ: OR = 1.15, 95% CI [1.07; 1.24]; SnM: OR = 1.13, 95% CI [1.06; 1.22]). Lower physical health mediated this risk for all profiles, although to a stronger extent for manual profiles (PQ: OR = 1.22, 95% CI [1.11; 1.34]; RM: OR = 1.12, 95% CI [1.06; 1.19]; SnM: OR = 1.04, 95% CI [1.00; 1.10]; Table 3). Thus, adverse job quality is associated with non-employment through mental health over time, while it is particularly the manual character of job quality that is associated with non-employment through physical health at the same time.

In a final step, health-mediation of job quality exposure from 2011 to 2014 on non-employment was tested in separate models for initially manual and non-manual groups respectively (Tables 4, 5). Among manual groups and in comparison to constant favourable exposure (RM-RM), those initially exposed to adverse job quality had a significantly increased risk of later non-employment through lower mental health when job quality remained adverse (PQ-PQ: OR = 1.44, 95% CI [1.23; 1.76], PQ-SnM: OR = 1.36, 95% CI [1.15; 1.70]; Table 4). The risk of later non-employment was less pronounced when changing to favourable job quality (PQ-RM: OR = 1.11, 95% CI [1.01; 1.24]). At the same time, those initially exposed to favourable job quality had a significantly increased risk mediated through lower mental health when job quality changed to adverse (RM-PQ: OR = 1.29, 95% CI [1.14; 1.51], RM-SnM: OR = 1.25, 95% CI [1.05; 1.55]). In addition, constant adverse manual job quality was associated with an increased risk of non-employment through lower physical health (PQ-PQ: OR = 1.11, 95% CI [1.03; 1.22]. This risk was significantly reduced, when those with favourable job quality changed to the favourable non-manual profile (RM-SR: OR = 0.87, 95% CI [0.78; 0.95]. It has to be noted though, that the significant indirect effects found among the manual change groups were consistently of small size.

Table 3 Estimates for parallel health-mediation of job quality in 2011 on non-employment in 2018

Direct effect estimates	**Mental health**		**Physical health**		**Non-employment**	
	B	**[95% CI]**	**B**	**[95% CI]**	**OR**	**[95% CI]**
Job quality in 2011						
PQ (n = 511)	**− 3.01**	**[− 4.10; − 1.91]**	**− 4.63**	**[− 5.55; − 3.72]**	**1.88**	**[1.18; 3.00]**
RM (n = 812)	0.05	[− 0.82; 0.92]	**− 2.65**	**[− 3.44; − 1.86]**	1.52	[0.97; 2.37]
SnM (n = 483)	**− 3.19**	**[− 4.21; − 2.10]**	**− 1.09**	**[− 2.04; − 0.14]**	0.86	[0.48; 1.56]
SR (n = 1,146)	(ref)	–	(ref)	–	(ref)	–
Mental health (n = 2,952)					**0.96**	**[0.95; 0.97]**
Physical health (n = 2,952)					**0.96**	**[0.94; 0.98]**

Indirect effect estimates	**Mental health on Non-employment**		**Physical health on Non-employment**	
	OR	**[95% CI]**	**OR**	**[95% CI]**
Job quality in 2011				
PQ (n = 511)	**1.15**	**[1.07; 1.24]**	**1.22**	**[1.11; 1.34]**
RM (n = 812)	1.00	[0.96; 1.03]	**1.12**	**[1.06; 1.19]**
SnM (n = 483)	**1.13**	**[1.06; 1.22]**	**1.04**	**[1.00; 1.10]**
SR (n = 1,146)	(ref)	–	(ref)	–

N = 2,952; all effects adjusted for cohort and sex; coefficients significant at $p < 0.05$ are presented in bold; B = unstandardised linear regression coefficient; OR = odds ratio; 95% CI = 95% confidence interval; ref = reference category; PQ = Poor Quality, RM = Relaxed Manual, SnM = Strained non-Manual, SR = Smooth Running.

Table 4 Estimates among initially manual groups for parallel health-mediation of job quality from 2011 to 2014 on non-employment in 2018

Direct effect estimates	n	Mental health ($R^2 = 0.09$)		Physical health ($R^2 = 0.05$)		Non-employment (Nagelkerke $R^2 = 0.13$)	
		B	[95% CI]	B	[95% CI]	OR	[95% CI]
Job quality change group							
PQ-PQ (– –)	228	**−6.45**	**[−8.09; −4.80]**	**−2.38**	**[−3.82; −0.94]**	1.50	[0.82; 2.74]
PQ-SnM (– –)	74	**−5.49**	**[−7.99; −2.98]**	0.21	[−2.00; 2.43]	0.50	[0.15; 1.75]
PQ-RM (– +)	164	**−1.76**	**[−3.83; −0.15]**	−0.64	[−2.19; 0.92]	0.74	[0.32; 1.69]
PQ-SR (– +)	45	−0.07	[−3.12; 2.98]	0.11	[−2.17; 2.38]	1.23	[0.35; 4.36]
RM-PQ (+ –)	130	**−4.45**	**[−6.26; −2.61]**	−0.72	[−2.53; 1.10]	1.49	[0.73; 3.05]
RM-SnM (+ –)	60	**−3.90**	**[−6.93; −0.87]**	2.47	[−0.05; 4.99]	0.46	[0.10; 2.05]
RM-SR (+ +)	175	0.08	[−1.54; 1.70]	**3.13**	**[1.64; 4.62]**	0.45	[0.15; 1.32]
RM-RM (+ +)	447	(ref)	–	(ref)	–	(ref)	–
Mental health	1,323					**0.95**	**[0.92; 0.97]**
Physical health	1,323					**0.96**	**[0.94; 0.98]**

Indirect effect estimates	n	Mental health on Non-employment		Physical health on Non-employment	
		OR	[95% CI]	OR	[95% CI]
Job quality change group					
PQ-PQ (– –)	288	**1.44**	**[1.23; 1.76]**	**1.11**	**[1.03; 1.22]**
PQ-SnM (– –)	74	**1.36**	**[1.15; 1.70]**	0.99	[0.90; 1.10]
PQ-RM (– +)	164	**1.11**	**[1.01; 1.24]**	1.03	[0.96; 1.11]
PQ-SR (– +)	45	1.00	[0.84; 1.20]	1.00	[0.90; 1.10]
RM-PQ (+ –)	130	**1.29**	**[1.14; 1.51]**	1.03	[0.96; 1.13]
RM-SnM (+ –)	60	**1.25**	**[1.05; 1.55]**	0.90	[0.78; 1.00]
RM-SR (+ +)	175	1.00	[0.91; 1.10]	**0.87**	**[0.78; 0.95]**
RM-RM (+ +)	447	(ref)	–	(ref)	–

N = 1,323; all effects adjusted for cohort and sex; coefficients significant at $p < 0.05$ are presented in bold; B = unstandardised linear regression coefficient; OR = odds ratio; 95% CI = 95% confidence interval; ref = reference category; PQ-PQ = Poor Quality 2011 + 2014, PQ-RM = Poor Quality 2011/Relaxed Manual 2014, PQ-SnM = Poor Quality 2011/Strained non-Manual 2014, PQ-SR = Poor Quality 2011/Smooth Running 2014, RM-PQ = Relaxed Manual 2011/Poor Quality 2014, RM-RM = Relaxed Manual 2011 + 2014, RM-SnM = Relaxed Manual 2011/Strained non-Manual 2014, RM-SR = Relaxed Manual 2011/Smooth Running 2014; (– –) denotes adverse job quality in 2011 and 2014, (– +) adverse job quality in 2011 and favourable quality in 2014, (+ –) favourable quality in 2011 and adverse quality in 2014, and (+ +) favourable job quality in 2011 and 2014.

Among non-manual groups and in comparison to constant favourable exposure (SR-SR), data indicated consistently that changing to manual profiles—regardless of the previous quality of non-manual exposure—was associated with an increased risk of non-employment through lower physical health. However, this trend consistently missed statistical significance (Table 5).

3.3 Sensitivity analyses

Overall attrition between 2011 and 2014 was 35.6%, between 2014 and 2018 it was 15.5%. As depicted in Table 1, the proportion of non-employed participants was significantly reduced in the final study sample (4.8%) compared to the total 2018 sample (8.5%), $\chi^2(1) = 50.73$, $p < 0.001$. An inspection of the raw data (not shown) regarding attrition among participants in job quality profiles showed that from 2011 to 2014 attrition in PQ was 37.7% and in RM 38.9%, whereas in SnM it was 31.8% and in SR 31.9%. When investigating attrition statistically, profile assignment in 2011 to PQ (OR = 1.29, 95% CI [1.12; 1.50]) and RM (OR = 1.36, 95% CI [1.20; 1.55]) both predicted attrition until 2014 significantly (in reference to SR).

The two-way analysis of variances for mental health as the dependent variable showed a main effect for profile assignment in 2011, $F(3; 6232) = 88.09$, $p < 0.001$, $\eta^2 = 0.04$, but not for participation status, $F(1; 6,232) = 1.40$, $p = 0.237$, and no interaction, $F(3; 6,232) = 1.03$, $p = 0.379$ (raw data not shown). The same pattern emerged for physical health as the dependent variable, with a main effect for profile assignment, $F(3; 6,232) = 79.14$, $p < 0.001$, $\eta^2 = 0.04$, but not for participation status, $F(1; 6,232) = 0.35$, $p = 0.556$, and no interaction, $F(3; 6,232) = 0.51$, $p = 0.676$.

Table 5 Estimates among initially non-manual groups for parallel health-mediation of job quality from 2011 to 2014 on non-employment in 2018

Direct effect estimates	n	Mental health ($R^2 = 0.07$)		Physical health ($R^2 = 0.07$)		Non-employment (Nagelkerke $R^2 = 0.05$)	
		B	[95% CI]	B	[95% CI]	OR	[95% CI]
Job quality change group							
SnM-PQ (– –)	63	**– 8.46**	**[– 11.22; – 5.70]**	**– 5.32**	**[– 7.98; – 2.66]**	1.28	[0.41; 4.00]
SnM-SnM (– –)	198	**– 5.49**	**[– 7.07; – 3.91]**	1.33	[– 2.71; 0.06]	0.49	[0.17; 1.43]
SnM-RM (– +)	56	– 1.94	[– 5.13; 1.26]	**– 2.96**	**[– 5.27; – 0.65]**	2.25	[0.82; 6.17]
SnM-SR (– +)	166	**– 1.55**	**[– 3.09; – 0.00]**	0.14	[– 1.25; 1.54]	0.65	[0.22; 1.89]
SR-PQ (+ –)	40	**– 5.75**	**[– 9.35; – 2.14]**	**– 3.74**	**[– 6.95; – 0.53]**	0.97	[0.22; 4.36]
SR-RM (+ +)	139	– 1.08	[– 2.89; 0.75]	**– 2.51**	**[– 4.18; – 0.85]**	0.56	[0.17; 1.90]
SR-SnM (+ –)	194	**– 4.41**	**[– 6.10; – 2.72]**	– 0.10	[– 1.43; 1.23]	0.79	[0.32; 1.95]
SR-SR (+ +)	773	(ref)	–	(ref)	–	(ref)	–
Mental health	1,629					0.98	[0.96; 1.01]
Physical health	1,629					**0.96**	**[0.94; 1.00]**

Indirect effect estimates	n	Mental health on Non-employment		Physical health on Non-employment	
		OR	[95% CI]	OR	[95% CI]
Job quality change group					
SnM-PQ (– –)	63	1.15	[0.91; 1.45]	1.19	[0.98; 1.50]
SnM-SnM (– –)	198	1.10	[0.94; 1.27]	1.05	[0.99; 1.14]
SnM-RM (– +)	56	1.03	[0.97; 1.15]	1.10	[0.99; 1.28]
SnM-SR (– +)	166	1.03	[0.98; 1.09]	1.00	[0.94; 1.05]
SR-PQ (+ –)	40	1.10	[0.94; 1.32]	1.13	[0.99; 1.39]
SR-RM (+ +)	139	1.02	[0.98; 1.08]	1.09	[0.99; 1.22]
SR-SnM (+ –)	194	1.08	[0.96; 1.22]	1.00	[0.95; 1.06]
SR-SR (+ +)	773	(ref)	–	(ref)	–

N = 1,629; all effects adjusted for cohort and sex; coefficients significant at $p < 0.05$ are presented in bold; B = unstandardised linear regression coefficient; OR = odds ratio; 95% CI = 95% confidence interval; ref = reference category; SnM-PQ = Strained non-Manual 2011/Poor Quality 2014, SnM-RM = Strained non-Manual 2011/Relaxed Manual 2014, SnM-SnM = Strained non-Manual 2011 + 2014, SnM-SR = Strained non-Manual 2011/Smooth Running 2014, SR-PQ = Smooth Running 2011/Poor Quality 2014, SR-RM = Smooth Running 2011/Relaxed Manual 2014, SR-SnM = Smooth Running 2011/Strained non-Manual 2014, SR-SR = Smooth Running 2011 + 2014; (– –) denotes adverse job quality in 2011 and 2014, (– +) adverse job quality in 2011 and favourable quality in 2014, (+ –) favourable quality in 2011 and adverse quality in 2014, and (+ +) favourable job quality in 2011 and 2014.

To summarise, these results indicate sample selection between 2011 and 2014 among workers in both manual job quality profiles due to attrition, which may have reduced the proportion of non-employed participants in the final analytical sample. There was no additional bias resulting from baseline mental and physical health differences among those lost through attrition until 2014.

4 Discussion

This study revealed different health-mediated associations of job quality change with non-employment in a national representative sample of older employees in Germany. Among initially manual workers, constant poor job quality was associated with a higher risk of non-employment, mediated through both poor mental and physical health; for deteriorating or improving job quality, this risk was mediated through poor mental health only. When changing from good manual to good non-manual work, the risk of non-employment was reduced, an effect mediated by better physical health. Among job quality groups of initially non-manual workers, no health-mediated risks of non-employment were found. The results underscore specific mental and physical vulnerabilities of manuals, with the consecutive risk of health-related early exit from paid employment (Hasselhorn 2020; Ní Léime et al. 2020; Phillipson 2019).

In the following, four main findings of the present study will be discussed:

- constant and temporary poor job quality does predominantly affect mental health,

- manual work does predominantly affect physical health,
- the effect of job quality on non-employment in later working life is particularly health-mediated,
- confirmation of change effects of job quality on health and employment.

4.1 Health-mediation of job quality effects

Our findings indicate an effect of job quality on employment in later working life, which is mainly attributed to health as implicated in previous studies (d'Errico et al. 2021; Knardahl et al. 2017; Robroek et al. 2013; Schram et al. 2020; Söderberg et al. 2021; van Zon et al. 2022). Yet, the findings emphasise that both work and health need to be looked at in a differentiated way, particularly in times of extended working lives.

Regarding mental health, we found that adversity affected health, both among manual and non-manual workers, respectively. Thereby, a gradient was observed: the association was weaker when job quality improved and it was absent when job quality remained favourable. This suggests that interruption of adverse exposure may allow for mental health recovery and prevent increased risk of non-employment. Since mental health was not associated with non-employment among non-manuals, this applies to manuals only.

Regarding physical health, we found that it was mainly the manual character of work affecting health. Constant exposure to adverse manual work was associated with poorer physical health. This association was absent among those changing to non-manual work and physical health even improved when moving from already favourable manual to non-manual work. Concurrently, physical health among non-manuals was poorer when changing to manual work, but when remaining in non-manual work, no physical health effects were observed. This pattern of findings suggests that interruption of physical strain may allow for recovery and prevent increased risk of non-employment. Over and above, the change from favourable manual to non-manual work may have the potential to enhance physical health with a consecutive positive effect on employment. Among initially non-manual groups, the findings consistently indicate a complementary trend.

In contrast to our findings, the only study explicitly investigating health-mediated effects of work factors on retirement did not find evidence for it (Mäcken 2019). This might be attributed to the limited consideration of working conditions and above, on the separate—and not parallel—examination of the health measures used (c.f. Mäcken 2019).

4.2 Job quality change

This study confirmed continuity and change effects of job quality on non-employment in later working life, and these effects are particularly health-mediated. To our knowledge, this has never been investigated before. However, two studies have investigated effects of job quality accumulation on health among older workers, but with different conceptual approaches to job quality. Welsh et al. (2016) used four single psychosocial work exposures only and conceptualised accumulation as the presence of two or more characteristics at annual assessments across eight years. In contrast to the reference groups, a significant decline of self-rated health, mental and physical health was found for older workers in constantly poor quality jobs. Burns et al. (2016) conceptualised job quality accumulation as the presence or absence of high job strain at three time points during an eight-year assessment period. While constant exposure to high job strain was associated with continued depression, onset or termination of job strain were followed by onset or remission of depression, respectively. Thus, both studies confirm long-term effects of job quality on later-life health, but do not link potential health consequences to employment participation.

4.3 Implications

Our research findings have different implications on the individual, organisational and national level. For older workers, the findings confirm that continued employment under poor working conditions is associated with higher risks of poor health, followed by higher risks of non-employment. Previous analyses of lidA data have shown that employer changes may help to substantially improve job quality, work ability and health (Garthe and Hasselhorn 2021). Many changers in this study had low occupational status, however, it should also be acknowledged that many workers in poor quality work find themselves in job lock situations (Garthe and Hasselhorn 2021). Organisations may learn from our findings that particularly among older manual workers the deterioration of job quality leads to psychological strain and that the reduction of physical work exposure is beneficial to the physical health of the workers. As a consequence, these health changes may affect the future employability of their workers. With respect to the national perspective, researchers have concluded that in most countries today, extended working lives measures are primarily focused on employment and exit ages and do not consider work quality and individual resources (Hasselhorn 2020; Ní Léime et al. 2020; Phillipson 2019). Our findings, however, clearly demonstrate the interrelationship of job quality and employment participation among older workers. The reflection of the association of job quality,

health and employment in policy may not only advance sustainability of such measures, but also increase the quality of life for many disadvantaged workers, thereby contributing to increase overall fairness of extended working lives policies.

Moreover, the assessment approach applied in the present study may stimulate the interdisciplinary scientific debate on the challenges associated with the measurement of job quality. Both approaches, the variable-centred and the person-centred analysis approach, have their strengths, weaknesses and their specific fields of application. With respect to the variable-centred analysis approach, a clear advantage of measuring single work factors lies in the possibility to detect and quantify main effects, cumulative effects as well as interactions (such as synergistic and buffering effects) between selected work characteristics with respect to health or employment outcomes. This approach is of particular relevance for preventive action at the work level.

However, it has been discussed recently by d´Errico et al. (2021), that single work factors show substantial conceptual and empirical overlap, especially within the physical and psychosocial work domains, respectively. This can pose serious statistical challenges, leading to the variables´ conceptual distinctiveness and interdependencies not being understood (d´Errico et al. 2021). A further notion is added by Knardahl et al. (2017), who point out that the effect found for a single job quality factor may be attributable to other correlated characteristics, even though these may not have been considered in the analysis. For example, workers exposed to shift work, such as in production or health-care, are often exposed to mechanical and chemical strains. Finally, Garthe and Hasselhorn (2021) describe the phenomenon that work factors change in concurrence. When investigating employer change among older workers in Germany, immediate secondary positive effects were found among the changers for all psychosocial variables assessed, namely leadership quality, support from colleagues, possibilities for development, influence at work and quantitative demands (Garthe and Hasselhorn 2021). Thus, the concurrent improvement of all observed psychosocial work variables indicates that changes found for single or some exposure variables may go along with concurrent changes of further unobserved variables. The conclusion is that findings derived from analyses based on the variable-centred approach always need to be considered and discussed in the light of potential concurrent job quality characteristics that may be accountable for the effects in question (Knardahl et al. 2017, p. 24).

A person-centred analysis approach, where a broad range of work factors is assessed simultaneously, may overcome the points discussed above. However, this occurs at the cost of the identification of specific job quality effects, as the contribution of single work factors cannot be disentangled from the broad effect of a profile. Instead, this approach has its indications where occupational (sub-)populations are regarded and understood in their overall work situation. This enables to identify and follow risk groups during the years of their transition from work to retirement for example.

4.4 Strengths and limitations

A main strength of this study is the combination of (a) the comprehensive measurement of job quality, namely by applying a person-centred approach (c.f. Bujacz et al. 2018, 2021; Carr et al. 2021; Eurofound 2016; Hasselhorn et al. 2020; Lowe 2007; van Aerden et al. 2015; Vanroelen et al. 2010), (b) the investigation of its continuity and change effects in (c) two cohorts representative for the German baby-boomer working population (Schröder et al. 2013; Steinwede et al. 2015, 2018). That way, our findings add to a differentiated understanding of the interplay of job quality and health in the work-retirement transition to the current body of literature. We acknowledge, however, that the person-centred approach on job quality assessment does not allow for the identification of main and interactive effects of specific single job factors on employment participation.

A limitation of this study is certainly the lower participation of socially disadvantaged workers at first follow-up, a phenomenon known from other cohorts (e.g. d'Errico et al. 2021). Thus, it may be assumed that effects found for the initially manual groups in our study may be underestimated. Next, all measures were assessed via self-report, which predisposes for common-method bias when measuring job quality and health in 2014. As the lidA study so far comprises three assessments only, we confirmed basic profile effects of job quality on non-employment by testing for a health-mediation in a prior analysis step (c.f. Table 3). In addition, non-employment could not be investigated in differentiation as in previous studies (e.g. d'Errico et al. 2021; Knardahl et al. 2017; Reeuwijk et al. 2017; Robroek et al. 2013; Söderberg et al. 2021; van Rijn et al. 2014), because the prevalence of typical exit routes such as disability and early retirement was too low in the lidA sample with the age groups investigated (Hasselhorn et al. 2014). Consequently, our condensed outcome measure could not capture specific exit routes that were shown to be associated with health measures previously (e.g. Reeuwijk et al. 2017; Robroek et al. 2013). It has to be noted though, that younger age groups of the older working population may have other reasons for early exit from employment than older age groups. Investigating disability retirement and early retirement as the outcome, may lead to inconclusive

findings for this part of the workforce. Last, some job quality change groups were small in size, resulting in wider confidence intervals for some effect estimates found to be statistically significant. Therefore, a replication with a larger sample would be preferred to improve robustness of the study results.

5 Conclusions

This study confirmed the risks and benefits of job quality for health and, consecutively, employment participation and underscores the importance of timely workplace improvements to maintain employability in later life-course. This should be considered when promoting longer working lives to prevent further accumulation of disadvantage among those in poor quality work. When investigating health, the diverging long-term effects of mental and physical health call for critical consideration of health measures in retirement research.

Abbreviations

AAPOR	The American Association for Public Opinion Research
COOP3	Cooperation rate 3
COPSOQ	Copenhagen Psychosocial Questionnaire
ERI	Efford-reward imbalance
IEB	Integrated employment biographies
OECD	The Organisation for Economic Co-Operation and Development
PQ	Poor Quality
PQ-PQ	Poor Quality 2011 + 2014
PQ-RM	Poor Quality 2011/Relaxed Manual 2014
PQ-SnM	Poor Quality 2011/Strained non-Manual 2014
PQ-SR	Poor Quality 2011/Smooth Running 2014
RM	Relaxed Manual
RM-PQ	Relaxed Manual 2011/Poor Quality 2014
RM-RM	Relaxed Manual 2011 + 2014
RM-SnM	Relaxed Manual 2011/Strained non-Manual 2014
RM-SR	Relaxed Manual 2011/Smooth Running 2014
RR5	Response rate 5
SF-12v2	Short Form Health Survey
SnM	Strained non-Manual
SnM-PQ	Strained non-Manual 2011/Poor Quality 2014
SnM-RM	Strained non-Manual 2011/Relaxed Manual 2014
SnM-SnM	Strained non-Manual 2011 + 2014
SnM-SR	Strained non-Manual 2011/Smooth Running 2014
SR	Smooth Running
SR-PQ	Smooth Running 2011/Poor Quality 2014
SR-RM	Smooth Running 2011/Relaxed Manual 2014
SR-SnM	Smooth Running 2011/Strained non-Manual 2014
SR-SR	Smooth Running 2011 + 2014
HF	High Flying

Acknowledgements

Not applicable.

Author contributions

MS, HMH and ME conceptualised the study. MS wrote the manuscript, performed all analyses and interpreted the data. HMH contributed to the interpretation of the data and the writing of the manuscript. All authors have read and approved the final manuscript.

Funding

The 2011 and 2014 waves of lidA were funded by the German Ministry of Education and Research (Grant No.: 01ER0806, 01ER0825, 01ER0826, 01ER0827). The 2018 wave of lidA was funded by the German Social Accident Insurance (Deutsche Gesetzliche Unfallversicherung, Grant no. FP-0403 lidA III). The funders were not involved in designing, data collecting, writing, nor submission of the present study.

Availability of data and materials

The datasets used for the current analysis are not publicly available due to protection of data privacy (www.lida-studie.de). A Scientific Use File will be available in 2023.

Declarations

Competing interests

The authors declare no competing interests.

Received: 1 December 2021 Accepted: 13 March 2023
Published online: 25 March 2023

References

Achatz, J., Gundert, S.: Arbeitsqualität und Jobsuche von erwerbstätigen Grundsicherungsbeziehern. Institut für Arbeitsmarkt- und Berufsforschung (IAB), Nürnberg (2017)

Amick, B.C., McLeod, C.B., Bültmann, U.: Labor markets and health: an integrated life course perspective. Scand J Work Environ Health. **42**(4), 346–353 (2016). https://doi.org/10.5271/sjweh.3567

Baxter, S., Blank, L., Cantrell, A., Goyder, E.: Is working in later life good for your health? A systematic review of health outcomes resulting from extended working lives. BMC Public Health (2021). https://doi.org/10.1186/s12889-021-11423-2

Bernard, P.B. (ed.): Musculoskeletal disorders and workplace factors. A critical review of epidemiological evidence for work-related musculoskeletal disoders of the neck, upper extremity, and low back. National Institute for Occupational Safety and Health, Cincinnati (1997)

Bujacz, A., Bernhard-Oettel, C., Rigotti, T., Magnusson Hanson, L., Lindfors, P.: Psychosocial working conditions among high-skilled workers: a latent transition analysis. J. Occup. Health Psychol. **23**(2), 223–236 (2018). https://doi.org/10.1037/ocp0000087

Bujacz, A., Rudman, A., Gustavsson, P., Dahlgren, A., Tucker, P.: Psychosocial working conditions of shiftworking nurses: a long-term latent transition analysis. J. Nurs. Manag. **29**(8), 2603–2610 (2021). https://doi.org/10.1111/jonm.13430

Burns, R.A., Butterworth, P., Anstey, K.J.: An examination of the long-term impact of job strain on mental health and wellbeing over a 12-year period. Soc. Psychiatry Psychiatr. Epidemiol. **51**(5), 725–733 (2016). https://doi.org/10.1007/s00127-016-1192-9

Muñoz de Bustillo, R, Fernández-Macías, E, Antón, JI, Esteve, F: Indicators of job quality in the European Union. European Parliament, Brussels (2009).

Carmichael, F., Ercolani, M.G.: Age-training gaps in the European Union. Ageing Soc. **34**, 129–156 (2014). https://doi.org/10.1017/S0144686X12000852

Carr, D.C., Jason, K., Taylor, M., Washington, T.R.: A brief report on older working caregivers: developing a typology of work environments. J. Gerontol. B. (2021). https://doi.org/10.1093/geronb/gbab131

Conen, W.S., Henkens, K., Schippers, J.: Employers' attitudes and actions towards the extension of working lives in Europe. Int. J. Manpow. **33**(6), 648–665 (2012). https://doi.org/10.1108/01437721211261804

d'Errico, A., Burr, H., Pattloch, D., Kersten, N., Rose, U.: Working conditions as risk factors for early exit from work: in a cohort of 2351 employees in Germany. Int. Arch. Occup. Environ. Health **94**(1), 117–138 (2021). https://doi.org/10.1007/s00420-020-01566-x

Dannefer, D.: Cumulative advantage/disadvantage and the life course: cross-fertilizing age and social science theory. J. Gerontol. B. **58**(6), S327–S337 (2003). https://doi.org/10.1093/geronb/58.6.S327

de Breij, S., Mäcken, J., Qvist, J.Y., Holman, D., Hess, M., Huisman, M., Deeg, D.J.H.: Educational differences in the influence of health on early work exit among older workers. Occup. Environ. Med. **77**(8), 568–575 (2020). https://doi.org/10.1136/oemed-2019-106253

Enders, C.K.: Applied missing data analysis. Guilford Press, New York (2010)

European Foundation for the Improvement of Living and Working Conditions: Sixth European Working Conditions Survey—Overview report. Publications Office of the European Union, Luxembourg (2016)
Federal Office of Statistics: Labour force participation. Employed and employment rate by sex and age 2009 and 2019. Federal Office of Statistics, Wiesbaden. https://www.destatis.de/DE/Themen/Arbeit/Arbeitsmarkt/Erwerbstaetigkeit/Tabellen/erwerbstaetige-erwerbstaetigenquote.html (2022). Accessed 05 September 2022.
Garthe, N., Hasselhorn, H.M.: Leaving and staying with the employer: changes in work, health and work ability among older workers. Int. Arch. Occup. Environ. Health. **94**, 85–93 (2021). https://doi.org/10.1007/s00420-020-01563-0
Hasselhorn, H.M., Peter, R., Rauch, A., Schröder, H., Swart, E., Bender, S., du Prel, J.-B., Ebener, M., March, S., Trappmann, M., Steinwede, J., Müller, B.H.: Cohort profile: The lidA cohort study—a German cohort study on work, age, health and work participation. Int. J. Epidemiol. **43**(6), 1736–1749 (2014). https://doi.org/10.1093/ije/dyu021
Hasselhorn, H.M., Stiller, M., du Prel, J.-B., Ebener, M.: Work profiles of older employees in Germany—results from the lidA-cohort study. BMC Public Health (2020). https://doi.org/10.1186/s12889-020-09542-3
Hasselhorn, H.M., Leinonen, T., Bültmann, U., Mehlum, I.S., du Prel, J.B., Kiran, S., Majery, N., Solovieva, S., de Wind, A.: The differentiated roles of health in the transition from work to retirement—conceptual and methodological challenges and avenues for future research. Scand. J. Work Environ. Health **48**(4), 312–321 (2022). https://doi.org/10.5271/sjweh.4017
Hasselhorn, M.H., Müller, B.H.: Arbeit und Gesundheit—Eine Bilanzierung aus 25 Jahren arbeitsepidemiologischer Forschung. In: Richter, G. (ed.) Arbeit und Altern 2021. Herausforderungen für Wirtschaft und Gesellschaft, pp. 171–198. Nomos, Baden-Baden (2021).
Hasselhorn, H.M.: Social inequality in the transition from work to retirement. In: Theorell, T. (ed.), Handbook of Socioeconomic Determinants of Occupational Health. Handbook Series in Occupational Health Sciences, pp. 1–26. Cham: Springer (2020).
Hayes, A.F.: Introduction to Mediation, Moderation, and Conditional Process Analysis. A Regression-Based Approach, 2nd ed. Guilford Press, New York (2017)
Howard, M.C., Hoffman, M.E.: Variable-centered, person-centered and person-specific approaches: where theory meets the method. Organ. Res. Methods. **21**(4), 846–876 (2017). https://doi.org/10.1177/2F1094428117744021
Jöckel, K.-H., Babitsch, B., Bellach, B.-M., Bloomfield, K., Hoffmeyer-Zlotnik, J., Winkler, J., Wolf, K.: Messung und Quantifizierung soziodemografischer Merkmale in epidemiologischen Studien. In: Ahrens, W., Bellach, B.-M., Jöckel, K.-H. (eds.) Messung und Quantifizierung soziodemografischer Merkmale in epidemiologischen Studien (RKI-Schrift 1/98). MMV Medizin Verlag, München (1998)
Knardahl, S., Johannessen, H.A., Sterud, T., Härmä, M., Rugulies, R., Seitsamo, J., Borg, V.: The contribution from psychological, social, and organizational work factors to risk of disability retirement: a systematic review with meta-analyses. BMC Public Health (2017). https://doi.org/10.1186/s12889-017-4059-4
Lowe, G.S.: 21st century job quality: achieving what Canadians want. Canadian Policy Research Networks, Ottawa (2007)
Mäcken, J.: Work stress among older employees on Germany: effects on health an retirement age. PLoS ONE (2019). https://doi.org/10.1371/journal.pone.0211487
Mayer, J., Kraus, T., Ochsmann, E.: Longitudinal evidence for the association between work-related physical exposures and neck and/or shoulder complaints: a systematic review. Int. Arch. Occup. Environ. Health **85**(6), 587–603 (2012). https://doi.org/10.1007/s00420-011-0701-0
Medin, J., Alexanderson, K.: Begreppen Hälsa och Hälsofrämjande—en litteraturstudie [The concepts of health and health promotion—a systematic literature review]. Studentlitteratur, Lund (2000)
Ní Léime, Á., Ogg, J., Rašticová, M., Street, D., Krekula, C., Bédiová, M., Madero-Cabib, I. (eds.) Extended Working Live Policies. International Gender and Health Perspectives. Springer, Cham (2020).
Niedhammer, I., Bertrais, S., Witt, K.: Psychosocial work exposures and health outcomes: a meta-review of 72 literature reviews with meta-analysis. Scand. J. Work Environ. Health (2021). https://doi.org/10.5271/sjweh.3968
Nübling, M., Andersen, H.H., Mühlbacher, A.: Entwicklung eines Verfahrens zur Berechnung der körperlichen und psychischen Summenskalen auf Basis der SOEP-Version des SF 12 (Algorithmus). Deutsches Institut für Wirtschaftsforschung (DIW), Berlin (2006)
The Organisation for Economic Co-Operation and Development. Key policies to promote longer working lives. Country note (Germany) 2007 to 2017. https://www.oecd.org/els/emp/Germany%20Key%20policies_Final.pdf (2018). Accessed 16 June 2021.
Pega, F., Hamzaoui, H., Náfrádi, B., Momen, N.C.: Global, regional and national burden of disease attributable to 19 selected occupational risk factors for 183 countries, 2000–2016: a systematic analysis from the WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury. Scand. J. Work Environ. Health **48**(2), 158–168 (2022). https://doi.org/10.5271/sjweh.4001
Phillipson, C.: 'Fuller' or 'extended' working lives? Critical perspectives on changing transitions from work to retirement. Ageing Soc. **39**(3), 629–650 (2019). https://doi.org/10.1017/S0144686X18000016
Reeuwijk, K.G., van Klaveren, D., van Rijn, R.M., Burdorf, A., Robroek, S.J.: The influence of poor health on competing exit routes from paid employment among older workers in 11 European countries. Scand. J. Work Environ. Health **43**(1), 24–33 (2017). https://doi.org/10.5271/sjweh.3601
Rijnhart, J.J.M., Twisk, J.W.R., Eekhout, I., Heymans, M.W.: Comparison of logistic-regression based methods for simple mediation analysis with a dichotomous outcome variable. BMC Med. Res. Methodol. **19**, 19 (2019). https://doi.org/10.1186/s12874-018-0654-z
Robroek, S.J., Schuring, M., Croezen, S., Stattin, M., Burdorf, A.: Poor health, unhealthy behaviors, and unfavorable work characteristics influence pathways of exit from paid employment among older workers in Europe: a four year follow-up study. Scand. J. Work Environ. Health **39**(2), 125–133 (2013). https://doi.org/10.5271/sjweh.3319
Romeu-Gordo, L., Sarter, K.L.: Extended working live policies: country experiences (Germany). In: Ní Léime, Á., Ogg, J., Rašticová, M., Street, D., Krekula, C., Bédiová, M., Madero-Cabib, I. (eds.) Extended Working Live Policies. International Gender and Health Perspectives, pp. 271–282. Springer, Cham (2020).
Scharn, M., Sewdas, R., Boot, C.R.L., Huisman, M., Lindeboom, M., van der Beek, A.J.: Domains and determinants of retirement timing: a systematic review of longitudinal studies. BMC Public Health (2018). https://doi.org/10.1186/s12889-018-5983-7
Schlick, C., Bruder, R., Luczak, H.: Arbeitswissenschaft, 4th edn. Springer, Berlin (2018)
Schram, J.L.D., Robroek, S.J.W., Ots, P., Brouwer, S., Burdorf, A., van Zon, S.K.R., Oude Hengel, K.M.: Influence of changing working conditions on exit from paid employment among workers with a chronic disease. Occup. Environ. Med. **77**(9), 628–633 (2020). https://doi.org/10.1136/oemed-2019-106383
Schröder, H., Kersting, A., Gilberg, R., Steinwede, J.: FDZ-Methodenreport 01/2013. Methodenbericht zur Haupterhebung lidA—leben in der Arbeit. Forschungsdatenzentrum (FDZ) der Bundesagentur für Arbeit am Institut für Arbeitsmarktforschung, Nürnberg (2013).
Söderberg, M., Stattin, M., Robroek, S.J., Burdorf, A., Järvholm, B.: Industry mobility and disability benefits in heavy manual jobs: a cohort study of Swedish construction workers. Scand. J. Work Environ. Health **47**(3), 217–223 (2021). https://doi.org/10.5271/shweh.3932
Steinwede, J., Kleudgen, M., Häring, A., Schröder, H.: FDZ-Methodenreport 07/2015. Methodenbericht zur Haupterhebung lidA—leben in der Arbeit, 2. Welle. Forschungsdatenzentrum (FDZ) der Bundesagentur für Arbeit am Institut für Arbeitsmarktforschung, Nürnberg (2015).
Steinwede, J., Ruiz Marcos, J., Kleudgen, M.: Methodenbericht lidA Welle 3. infas Institut für angewandte Sozialwissenschaft, Bonn (2018).
Stiller, M., Garthe, N., Hasselhorn, H.M.: Job quality trajetories among baby-boomers in Germany and their consequences for the motivation to work—Results from the lidA cohort study. Ageing Soc. 1–23 (2021). 10.1017S0144686X21001343
The American Association for Public Opinion Research: Standard Definitions: Final dispositions of case codes and outcome rates for surveys, 9th edn. American Association for Public Opinion Research, Washington (2016)
The Organisation for Economic Co-Operation and Development: Pensions at a Glance 2019: OECD and G20 Indicators. OEDC Publishing, Paris (2019)
Theorell, T., Hammarström, A., Aronsson, G., Träskman Bendz, L., Grape, T., Hogstedt, C., Marteinsdottir, I., Skoog, I., Hall, C.: A systematic review including meta-analysis of work environment and depressive symptoms. BMC Public Health **15**, 738 (2015). https://doi.org/10.1186/s12889-015-1954-4

van Aerden, K., Moors, G., Levecque, K., Vanroelen, C.: The relationship between employment quality and work-related well-being in the European labor force. J. Vocat. Behav. **86**, 66–76 (2015). https://doi.org/10.1016/j.jvb.2014.11.001

van Rijn, R.M., Robroek, S.J.W., Brouwer, S., Burdorf, A.: Influence of poor health on exit from paid employment: a systematic review. Occup. Environ. Med. **71**(4), 295–301 (2014). https://doi.org/10.1136/oemed-2013-101591

van Zon, S.K.R., Ots, P., Robroek, S.J.W., Burdorf, A., Oude Hengel, K.M., Brouwer, S.: Do chronic diseases moderate the association between psychosocial working conditions and work exit? Longitudinal results from 55 950 Dutch workers. J. Epidemiol. Community Health. (2022). https://doi.org/10.1136/jech-2021-218432

van den Berg, T., Elders, L.A., Burdorf, A.: Influence of health and work on early retirement. J. Occup. Environ. Med. **52**(6), 576–583 (2010a). https://doi.org/10.1097/JOM.0b013e3181de8133

van den Berg, T., Schuring, M., Avendano, M., Mackenbach, J., Burdorf, A.: The impact of ill health on exit from paid employment in Europe among older workers. Occup. Environ. Med. **67**(12), 845–852 (2010b). https://doi.org/10.1136/oem.2009.051730

Vanroelen, C., Louckx, F., Moors, G., Levecque, K.: The clustering of health-related occupational stressors among contemporary wage-earners. Eur. J. Work Organ. Psychol. **19**(6), 654–674 (2010). https://doi.org/10.1080/13594320903043393

Varekamp, I., van Dijk, F.J., Kroll, L.E.: Workers with a chronic disease and work disability. Problems and solutions. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. **56**(3), 406–414 (2013). https://doi.org/10.1007/s00103-012-1621-1

Welsh, J., Strazdins, L., Charlesworth, S., Kulik, C.T., Butterworth, P.: Health or harm? A cohort study of the importance of job quality in extended workforce participation by older adults. BMC Public Health (2016). https://doi.org/10.1186/s12889-016-3478-y

Wikman, A., Marklund, S., Alexanderson, K.: Illness, disease, and sickness absence: an empirical test of differences between concepts of ill health. J. Epidemiol. Community Health. **59**(6), 450–454 (2005). https://doi.org/10.1136/jech.2004.025346

Zoer, I., Ruitenburg, M.M., Botje, D., Frings-Dresen, M.H.W., Sluiter, J.K.: The associations between psychosocial workload and and mental health complaints in different age groups. Ergonomics **54**(10), 943–952 (2011). https://doi.org/10.1080/00140139.2011.606920

Publisher's Note