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# Structure of job quality among older employees in Germany and its role for health and employment

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## Abstract

In upcoming decades, the promotion of job quality will play a crucial role in managing the effects of demographic ageing in Germany. Good working conditions may enable older workers to maintain health and well-being and to (be motivated to) remain longer in working life. Instead, the impact of adverse working conditions – by now – reduces indirectly their availability to the labour market before reaching statutory retirement age. To counteract the repercussions of a shrinking workforce, policy aims for the extension of working lives and the promotion of working conditions. In doing so, the focus of political strategies lied mainly on later retirement entry though. A fair implementation of such strategies and associated measures, however, requires knowledge about older employees with their working conditions and associated risks and potentials.

To shed light on the working situation of older employees in Germany, it is the aim of this thesis to characterize their job quality in its entirety, to quantify distinct groups based on typical exposure constellations, and to investigate effects of job quality exposure on health, motivation to work, and employment. The job quality concept of the „European Foundation for the Improvement of Living and Working Conditions" (2017) was adapted for this purpose, as it integrates demands and resources at the job level that influence health and well-being of workers. This thesis consists of three studies published in international peer-reviewed journals. All analyses are based on data from the first three waves of the German lidA („leben in der Arbeit") cohort study, assessed in 2011, 2014, and 2018. lidA is a prospective study on work, age, health, and employment participation representative for socially insured employees in Germany born either in 1959 or 1965.

Study I explores whether a typology of job quality profiles can be identified among older workers based on the following dimensions of working conditions: physical exposure, working time quality, work intensity, skills and discretion, social environment, quality of leadership, continued education, earnings, and prospects. A latent profile analysis was performed on lidA data from 2011, with additional data from 2014 and 2018 used for profile validation. A solution with five profiles was identified. An adverse (labelled „Poor Quality"; 18,7%) and a favourable profile („Relaxed Manual"; 30,0%) applied to workers with similar sociodemographic characteristics and predominantly manual work, respectively. „Poor Quality" comprised almost only demands, whereas „Relaxed Manual" had lower work intensity and more social resources. Another adverse („Strained non-Manual"; 15,5%) and favourable profile („Smooth Running"; 32,9%) applied to workers with similar sociodemographic characteristics and predominantly non-manual work, respectively. „Strained non-Manual" had high work intensity as well as lack of social resources and prospects, whereas „Smooth Running" comprised almost only resources. The last, also favourable profile („High Flying"; 2,9%) applied to a special group of predominantly non-manual workers with extremely high earnings besides the resource-rich constellation of „Smooth Running". Using mixed-design analyses of variances, the five profiles

demonstrated diverging associations with health, work-privacy-conflict, and work ability, thus representing qualitatively distinct subgroups of the older working population in Germany.

In study II, stability of the profiles from study I is explored between 2011, 2014, and 2018, and effects of selected job quality trajectories on the motivation to work in 2018 are tested. Over time, the proportion of workers in manual profiles decreased, while that in non-manual profiles increased. A log-linear analysis revealed large effects for profile continuity, respectively, yet profile changes were apparent for large parts of the sample. Across profiles, 35,1% had seven-years constant job quality. Among those in manual profiles, planned post-hoc contrasts revealed that constant favourable job quality exposure was associated with high motivation to work, timely job quality improvement was associated with higher levels and a lagged improvement with lower levels of this motivation. A similar pattern also emerged among workers in non-manual profiles. In addition, early job quality deterioration was associated with a lower motivation to work among them.

Study III focusses on the health mechanisms through which job quality exposure between 2011 and 2014 affects the risk of non-employment in 2018. In total, half of the sample experienced constant favourable job quality and nearly one fifth experienced constant adverse exposure. Improvements of job quality, its deterioration, or changes from manual to non-manual profiles (and vice versa) applied to smaller amounts, respectively. Regression models among initially manual groups and with mental and physical health in 2014 as parallel mediators showed, that constant adverse exposure, a change from adverse to favourable manual job quality, or deteriorating job quality were associated with increased risk of non-employment, mediated through poor mental health in each instance. Continuity of adverse manual job quality was also associated with such a risk, however mediated through poor physical health. This risk was reduced when constant favourable job quality included a change to non-manual work and was mediated through better physical health. Among initially non-manual groups, no health-mediation was found.

In summary, the studies showed that a typological approach may suit to reflect the heterogeneity of the older workforce in Germany with respect to their overall working situation. More than one third of the older working population can draw upon multiple job resources, which demonstrated beneficial effects on the outcomes investigated over the course of time. Concurrently, another third in predominantly manual work can draw upon specific psychosocial job resources, which do not compensate for health effects of physical strain. However, the remaining effects qualify this work environment as potentially favourable to some degree. Finally, more than another third of older employees are exposed to adverse working conditions, and the associated continuity and change effects – particularly in manual jobs – highlight these workers as vulnerable groups with increased risk of poor health, low motivation to work, and early exit from employment.

The results may help organizations, when designing and implementing targeted strategies to maintain and promote employability. They also demand policymakers to acknowledge and expand the consideration of job quality differences, and to address it timely to ensure fairness of reforms for the extension of working lives. In future research, earlier and longer monitoring periods are needed to depict better the course and consequences of long-term job quality exposure. In addition, a differentiated view on job quality is required in scientific research, not least when examining deviating mechanisms that may lead to non-employment of older workers particularly in non-manual jobs.

*Keywords:* job quality; older worker; motivation to work; health; employment participation

## Abstract (German)

Die Förderung von Arbeitsqualität wird in den kommenden Jahrzehnten eine entscheidende Rolle spielen, um die Auswirkungen demografischen Alterns in Deutschland zu bewältigen. Gute Arbeitsbedingungen können ältere Beschäftigte befähigen, Gesundheit und Wohlbefinden zu erhalten und (motiviert zu sein) länger im Erwerbsleben zu verbleiben. Die Auswirkungen schlechter Arbeitsbedingungen hingegen reduzieren indirekt bereits heute die Verfügbarkeit von Beschäftigten auf dem Arbeitsmarkt, bevor diese das Regelrentenalter erreichen. Um den Folgen einer schrumpfenden Erwerbsbevölkerung entgegenzuwirken, strebt die Politik die Verlängerung des Erwerbslebens und die Verbesserung von Arbeitsbedingungen an. Sie fokussierte in politischen Strategien bisher aber hauptsächlich einen späteren Renteneintritt. Für eine nachhaltige Umsetzung solcher Strategien und damit verbundener Maßnahmen ist es jedoch erforderlich, ältere Erwerbstätige mit ihren Arbeitsbedingungen und den damit verbundenen Risiken und Chancen zu kennen.

Um Aufschluss über die Arbeitssituation älterer Beschäftigter in Deutschland zu erlangen, ist das Ziel dieser Dissertation, deren Arbeitsqualität als Gesamtes zu charakterisieren, unterschiedliche Gruppen anhand typischer Expositionskonstellationen zu quantifizieren und damit verbundene Konsequenzen für deren Gesundheit, die Motivation, erwerbstätig zu sein, und deren Erwerbsteilhabe zu untersuchen. Hierfür wurde das Konzept von Arbeitsqualität der „Europäischen Stiftung zur Verbesserung der Lebens- und Arbeitsbedingungen“ (European Foundation for the Improvement of Living and Working Conditions [Eurofound], 2017) adaptiert, da es jene Anforderungen und Ressourcen auf Arbeitsplatzebene beinhaltet, die Gesundheit und Wohlbefinden von Erwerbstätigen nachweislich beeinflussen. Die vorgelegte Dissertation besteht aus drei Artikeln, die in international anerkannten Fachzeitschriften mit Gutachterverfahren publiziert wurden. Alle Auswertungen basieren auf Daten der ersten drei Wellen der lidA („leben in der Arbeit“)-Kohortenstudie in den Jahren 2011, 2014 und 2018. lidA ist eine prospektive Studie zu Arbeit, Alter, Gesundheit und Erwerbsteilhabe und ist repräsentativ für sozialversicherungspflichtig Beschäftigte der Geburtenjahrgängen 1959 und 1965 in Deutschland.

Studie I geht der Frage nach, ob eine Typologie von Profilen der Arbeitsqualität bei älteren Beschäftigten anhand folgender Dimensionen von Arbeitsbedingungen identifiziert werden kann: physikalische Exposition, Arbeitszeitqualität, Arbeitsintensität, Entwicklungs- und Entscheidungsmöglichkeiten, soziales Umfeld, Führungsqualität, Weiterbildung, Verdienst und Berufsaussichten. Es wurde eine latente Profilanalyse mit lidA-Daten aus 2011 durchgeführt, die Profilvalidierung erfolgte unter Hinzunahme der Daten aus 2014 und 2018. Durch die Analyse wurde ein Modell mit fünf Profilen identifiziert. Bei manueller Tätigkeit, trifft ein adverses (genannt „Poor Quality”; 18,7%) und ein förderliches Profil („Relaxed Manual”; 30,0%) jeweils auf Beschäftigte mit ähnlichen soziodemografischen Merkmalen zu. „Poor Quality” beinhaltet fast ausschließlich adverse

Arbeitsanforderungen, während „Relaxed Manual" niedrige Arbeitsintensität und mehr soziale Ressourcen aufwies. Bei nicht-manueller Tätigkeit, trifft ebenfalls ein weiteres adverses („Strained non-Manual"; 15,5%) und förderliches Profil („Smooth Running"; 32,9%) jeweils auf Beschäftigte mit ähnlichen soziodemografischen Merkmalen zu. „Strained non-Manual" repräsentiert hohe Arbeitsintensität und wenig soziale Ressourcen, während „Smooth Running" fast für alle Dimensionen Ressourcen aufweist. Das letzte, ebenfalls förderliche Profil („High Flying"; 2,9%) trifft auf eine besondere Gruppe vorrangig nicht-manuell Tätiger zu, und weist zusätzlich zur ressourcenreichen Konstellation von „Smooth Running" einen extrem hohen Verdienst als Charakteristikum auf. In gemischt-faktoriellen Varianzanalysen zeigten sich zwischen den Profilen abweichende Zusammenhangsmuster mit Gesundheit, Arbeit-/Privatleben-Konflikt und Arbeitsfähigkeit. Die Ergebnisse stützen die Annahme, dass die Profile homogene Subgruppen in der älteren Erwerbsbevölkerung in Deutschland repräsentieren, die sich hinsichtlich ihrer Arbeitsqualität unterscheiden.

Studie II untersucht die Stabilität der, in Studie I identifizierten, Profile zwischen 2011, 2014 und 2018, und testet Effekte ausgewählter Trajektorien der Arbeitsqualität auf die Motivation, erwerbstätig zu sein, im Jahr 2018. Der Anteil Erwerbstätiger in manuellen Profilen sank über die Zeit, während jener in nicht-manuellen Profilen anstieg. Eine log-lineare Analyse zeigte große Effekte für Profilkontinuität, gleichzeitig fielen Profilwechsel für weite Teile der Stichprobe auf. Über alle Profile hinweg hatten insgesamt 35,1% der Stichprobe eine über sieben Jahre stabile Arbeitsqualität. Für Beschäftigte in manuellen Profilen zeigten geplante post-hoc Kontraste, dass konstant förderliche Arbeitsqualität mit hoher Motivation, erwerbstätig zu sein, verbunden ist. Frühzeitige Verbesserungen der Arbeitsqualität sind mit höherer Motivation verbunden, verzögerte Verbesserungen mit niedrigerer Motivation. In nicht-manuellen Profilen zeigte sich ein vergleichbares Muster. Zudem ist hier eine frühzeitige Verschlechterung der Arbeitsqualität mit niedrigerer Motivation, erwerbstätig zu sein, verbunden.

Studie III fokussiert die Gesundheitsmechanismen, durch die sich die Arbeitsqualität zwischen 2011 und 2014 auf das Risiko für Nicht-Erwerbstätigkeit im Jahr 2018 auswirkt. Insgesamt erlebte etwa die Hälfte der Stichprobe konstant förderliche- und fast ein Fünftel eine konstant adverse Exposition. Verbesserungen und Verschlechterungen der Arbeitsqualität, oder ein Wechsel von manueller zu nicht-manueller Tätigkeit (und umgekehrt) trafen jeweils auf geringere Anteile zu. Bei initial manuell Tätigen zeigten Regressionsmodelle mit mentaler und physischer Gesundheit im Jahr 2014 als parallele Mediatoren, dass konstant adverse Exposition, ein Wechsel von adverser zu förderlicher manueller Arbeitsqualität oder eine Verschlechterung der Arbeitsqualität mit einem erhöhten Risiko für Nicht-Erwerbstätigkeit verbunden waren, und dass dies jeweils durch schlechte mentale Gesundheit vermittelt wurde. Ein erhöhtes Risiko wurde bei Konstanz von adverser manueller Exposition auch

durch schlechte physische Gesundheit vermittelt. Bei konstant förderlicher Exposition und einem Wechsel zu nicht-manueller Tätigkeit war das Risiko für Nicht-Erwerbstätigkeit reduziert, was durch bessere physische Gesundheit vermittelt wurde. Bei initial nicht-manuell Tätigen wurden keine Mediationseffekte gefunden.

Zusammengefasst zeigen die Studien, dass ein typologischer Ansatz geeignet zu sein scheint, um die Heterogenität der älteren Erwerbsbevölkerung und ihrer gesamten Arbeitssituation abzubilden. Mehr als ein Drittel der älteren Beschäftigten kann auf viele Ressourcen am Arbeitsplatz zurückgreifen, womit förderliche Effekte auf die untersuchten Endpunkte verbunden waren. Gleichzeitig verfügt ein weiteres Drittel, vorrangig in manueller Tätigkeit, über spezifische psychosoziale Ressourcen. Diese gleichen zwar nicht die gesundheitlichen Folgen physischer Belastungen aus, die gefundenen Effekte weisen diese Konstellation jedoch als im gewissen Umfang potenziell förderliches Arbeitsumfeld aus. Schließlich ist mehr als ein weiteres Drittel der älteren Erwerbsbevölkerung advers exponiert, und die hiermit verbundenen Effekte konstanter und veränderter Arbeitsqualität – insbesondere bei manueller Tätigkeit – weisen diese Beschäftigten als vulnerable Gruppen mit erhöhtem Risiko für Gesundheitseinschränkungen, geringe Motivation, erwerbstätig zu sein, und einen frühen Erwerbsausstieg aus.

Die Ergebnisse können Betrieben helfen, gezielte Strategien zum Erhalt und zur Förderung der Beschäftigungsfähigkeit zu entwerfen und zu implementieren. Sie zeigen auch, dass es von Seiten politischer Entscheidungsträger erforderlich ist, Unterschiede in der Arbeitsqualität anzuerkennen, stärker zu berücksichtigen und hier frühzeitig anzusetzen, um die soziale Angemessenheit von Reformen zur Verlängerung von Erwerbsbiografien zu gewährleisten. In zukünftiger Forschung sind früher einsetzende und insgesamt längere Beobachtungzeiträume erforderlich, um den Verlauf und die Langzeitfolgen der erlebten Arbeitsqualität besser abbilden zu können. Zudem ist eine differenziertere Sicht auf Arbeitsqualität in der Forschung notwendig, nicht zuletzt bei der Untersuchung abweichender Mechanismen, die zu Nicht-Erwerbstätigkeit bei älteren Beschäftigten führen können, insbesondere bei nicht-manueller Tätigkeit.

*Schlagwörter:* Arbeitsqualität; ältere Beschäftigte; Gesundheit; Motivation, erwerbstätig zu sein; Erwerbsteilhabe

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## List of abbreviations

ANOVA ..... *analysis of variances*
ArbSchG ..... *Arbeitsschutzgesetz*
COPSOQ ..... *Copenhagen Psychosocial Questionnaire*
ERI ..... *efford-reward imbalance*
ETUI ..... *European Trade Union Institute*
EWL ..... *extended working lives*
HF ..... *High Flying*
ILO ..... *International Labour Organization*
lidA ..... *leben in der Arbeit*
LPA ..... *latent profile analysis*
MTW ..... *motivation to work*
OECD ..... *Organization for Economic Co-operation and Development*
PQ ..... *Poor Quality*
PQ-PQ ..... *Poor Quality in 2011 + 2014*
PQ–PQ–PQ ..... *Poor Quality in 2011 + 2014 + 2018*
PQ–PQ–RM ..... *Poor Quality in 2011 + 2014 + Relaxed Manual in 2018*
PQ-RM ..... *Poor Quality in 2011 + Relaxed Manual in 2014*
PQ-RM-RM ..... *Poor Quality in 2011 + Relaxed Manual in 2014 + 2018*
PQ-SnM ..... *Poor Quality in 2011 + Strained non-Manual in 2014*
PQ-SR ..... *Poor Quality in 2011 + Smooth Running in 2014*
RM ..... *Relaxed Manual*
RM-PQ ..... *Relaxed Manual in 2011 + Poor Quality in 2014*
RM–PQ–PQ ..... *Relaxed Manual in 2011 + Poor Quality in 2014 + 2018*
RM-RM ..... *Relaxed Manual in 2011 + 2014*
RM-RM-PQ ..... *Relaxed Manual in 2011 + 2014 + Poor Quality in 2018*
RM–RM–RM ..... *Relaxed Manual in 2011 + 2014 + 2018*
RM-SnM ..... *Relaxed Manual in 2011 + Strained non-Manual in 2014*
RM-SR ..... *Relaxed Manual in 2011 + Smooth Running in 2014*
SF-12v2 ..... *Short Form Health Survey Version 2*
SnM ..... *Strained non-Manual*
SnM-PQ ..... *Strained non-Manual in 2011 + Poor Quality in 2014*
SnM-RM ..... *Strained non-Manual in 2011 + Relaxed Manual in 2014*
SnM-SnM ..... *Strained non-Manual in 2011 + 2014*

SnM-SR .....*Strained non-Manual in 2011 + Smooth Running in 2014*

SR.....*Smooth Running*

SR-PQ.....*Smooth Running in 2011 + Poor Quality in 2014*

SR-RM .....*Smooth Running in 2011 + Relaxed Manual in 2014*

SR-SnM .....*Smooth Running in 2011 + Strained non-Manual in 2014*

SR-SnM-SnM.....*Smooth Running in 2011 + Strained non-Manual in 2014 + 2018*

SR-SR.....*Smooth Running in 2011 + 2014, Smooth Running in 2011 + 2014*

WAI .....*Work Ability Index*

## Preface

This thesis consists of a general introduction and discussion as well as the following three studies previously published in international peer-reviewed scientific journals:

I. Hasselhorn*, H. M., Stiller*, M., du Prel, J.-B., & Ebener, M. (2020). Work profiles of older employees in Germany – results from the lidA cohort study. *BMC Public Health, 20*, 1452. https://doi.org/10.1186/s12889-020-09542-3
 * joint first authorship

II. Stiller, M., Garthe, N., & Hasselhorn, H. M. (2023b). Job quality trajectories among baby-boomers in Germany and their consequences for the motivation to work – results from the lidA cohort study. *Ageing & Society, 43*(7), 1638-1660. https://doi.org/10.1017/S0144686X21001343

III. Stiller, M., Ebener, M., & Hasselhorn, H. M. (2023a). Job quality change in later working life and the mediating role of mental and physical health for employment participation. *Journal for Labour Market Research, 57*, 12. https://doi.org/10.1186/s12651-023-00339-6

# 1 General Introduction

People spend much of their lifetime at work and it is not surprising that work has a positive impact on health and well-being (Barnay, 2016; Burgard & Lin, 2013; van der Noordt et al., 2014): it is a means to obtain financial resources that in turn are essential for financial well-being and societal participation. It contributes to meeting psychosocial needs and is central to personal identity, social roles, and status (Waddell & Burton, 2006). Unemployment, in contrast, is commonly associated with poor health outcomes and higher mortality (van de Ven, et al., 2022; Waddell & Burton, 2006), and, conversely, re-employment is associated with improved health and functioning (Gebel & Voßemer, 2014; Schuring et al., 2017; van de Ven et al., 2022; Waddell & Burton, 2006) – both underpinning the beneficial role of work for quality of life (Green et al., 2024). However, extensive research over the past decades has shown repeatedly that exposure to high levels of physical work demands and hazards increase the risk of physical health impairments (Bernard, 1997; Burgard & Lin, 2013), and that a variety of psychosocial work factors increase the risk of poor outcomes of both physical (Burgard & Lin, 2013; Dragano et al., 2017; Kivimäki & Kawachi, 2015; Niedhammer et al., 2021; Pena-Gralle et al., 2022) and mental health alike (Burgard & Lin, 2013; Niedhammer et al., 2021; Rugulies et al., 2017; Seidler et al., 2022; Theorell et al., 2015). To summarize it with Muñoz de Bustillo and colleagues (2011): „[…] Not all jobs are the same. There are `good´ and `bad´ jobs" (p. 448). **Consequently, the question arises when a job is `good´ or `bad´, and who benefits from good work.**

It is a central aim of this dissertation to address these questions for the German labour market by investigating the quality of the job among the highly important working group of baby boomers, who constitute about 24 % of the German working population currently[1] and who are about to transition to retirement in the next years. This thesis consists of three scientific papers published previously in international peer-reviewed journals and it is structured in three main chapters. In the first chapter, a general introduction is provided on the central topic of this thesis, by deducing its theoretical background and research context (1.1), and by narrowing the scientific research perspective adopted in it (1.2). Next, different conceptual and measurement approaches to the concept of job quality (1.3) are elaborated and contrasted, previous empirical findings on job quality effects across working life (1.4) are summarized, and aim and scope of the thesis (1.5) are outlined to address the respective research gaps. In chapter 2, a summary is given of each study published previously. Chapter 3 closes with a detailed discussion of the study results, its implications on the meso- and macro-level, and provides a conclusion with outlook.

[1] As of May 19th in 2025, age group 55-64 years (Federal Office of Statistics, 2025).

### 1.1 The work environment in times of extended working lives

In Germany, the need to retain older workers for more years in paid employment will continue to increase in upcoming decades. An ageing society and a workforce projected to shrink concurrently (Organization for Economic Co-operation and Development [OECD], 2019, p. 175) both seriously challenge the sustainability of the German public pension system just as in most Western European countries. Against the backdrop of this demographic trend, it is a policy priority to increase employment participation and to extend working careers, particularly among high-risk groups for labour market exclusion such as older workers (Heywood & Jirjahn, 2016; OECD, 2018a). Following this agenda, initiatives for the establishment of such *extended working lives* (EWL) aim at both increasing the statutory retirement age and promoting health and employability through better job quality (OECD, 2018b). So far, policy measures focus mostly on extending employment though (Hofäcker & Hess, 2022; Hofäcker & Naumann, 2015), which, however, may affect the group of older workers differently on multiple levels. It follows, that when demanding additional years in work for that working age group, several considerations need to be made.

First, as a consequence of biological ageing and differential life-long work exposure, older workers find themselves confronted with normative health changes, ageing-related functional decline, and reduced mental and physical capacities (Crawford et al., 2010; Waddell & Burton, 2006; Wegman & McGee, 2004). They also have an increased need for recovery when working full-time (Devereux & Rydstedt, 2009; Kiss et al., 2008), which is critical considering that recovery experiences mediate the association of work characteristics with well-being (Bennett et al., 2018). At this working life stage, older workers may also exhibit higher susceptibility to certain occupational risks (Noone & Bohle, 2017). Each of the above aspects as well as their complex interplay may affect the adaptability and work performance of older workers and – regardless of positive changes such as enhanced capabilities and performance due to increased work experience – reflects an ageing-related vulnerability in the context of work in the first place (Jones et al., 2013). Accordingly, EWL in an adverse or even hazardous work environment may represent an unreasonable burden for certain groups such as low-skilled older workers (Burdorf et al., 2023). These individuals may lack personal resources to adapt to additional years in their work environment, leaving them systematically overchallenged in this working life-stage, whereas others might be enabled to cope better (Meng et al., 2017; van der Klink et al., 2016). **Against this backdrop, more years in work might disadvantage certain older groups in the workforce.**

Next, older workers are also affected by the changing nature of work in a specific manner. Over the last decades, technological progress, globalization, and a higher labour market flexibility have led to an increase in non-standard forms of employment and changes in organizational work patterns, which marks a shift from the traditional type of full-time, indefinite work as part of a work contract (International Labour Organization [ILO], 2016). Non-standard forms of employment include part-time

work, temporary employment, multiple-party-, or disguised employment, and the respective jobs – besides the opportunities they can offer – are frequently accompanied by poor working conditions in terms of long working hours, increased work intensity, uncommon hours or working schedules (Quinlan, 2015), and the respective occupational safety and health risks (ILO, 2016). It is important to consider that older workers have a higher likelihood of being in non-standard employment in general (Park et al., 2019; OECD 2019) and at greater risk to be so involuntarily (Green & Livanos, 2017). Certain older workers in non-standard employment, especially males, are at greater risk of working in unstable occupations and of exposure to occupational hazards and musculoskeletal pain than those performing other types of work (Park et al., 2019). It was also found that moving from full-time employment to non-standard employment has negative effects on mental health, particularly for older women (Wels & Takami, 2021) and that temporary employment is associated with longer depression-related disability episodes (Ervasti et al., 2014). Particularly in the context of EWL, it is noteworthy that part-time work is sometimes used by companies to retain or re-employ older workers (ILO, 2016), which may represent a positive outcome from current EWL policy practice. On an individual level, the respective older workers might feel forced to work for additional years in forms of employment (Loughlin & Murray, 2013) that are associated with adverse working conditions and greater financial and job insecurity though (Eichhorst et al., 2013), particularly when re-entering into employment after unemployment is impeded (Brussig, 2015). **In consequence, more years in work might disadvantage older workers also through adverse work exposure and its health effects associated with new forms of employment and work organization.**

Further, the promotion of EWL needs to consider life-long workplace exposure. Older workers find themselves in a stage, when life is normatively associated with the timing of retirement while, at the same time, having already been subjected to life-long workplace exposure (Amick et al., 2016; Baltes et al., 2012). In this context, their working conditions may represent an outcome of their employment trajectory (Kaboth et al., 2023; Nilsen, et al., 2022), a co-determinant of their health and well-being status (Amilon et al., 2024), as well as an antecedent, moderator, or mediator for exit routes from employment or retirement timing, respectively (Browne et al., 2019; Leijten et al., 2015; Schram et al., 2020; Topa et al., 2009). As was documented very recently in the full range of working age across European countries, the quality of the job – alongside general health – accounts most for the variation in general well-being (Green et al., 2024), and it is highly probable that this effect is more pronounced among older working age groups. For instance, working conditions with high physical (Böckerman & Ilmakunnas, 2020; d'Errico et al., 2021) and mental demands were shown to be systematically associated with early, health-related exit from employment (Dragano & Schneider, 2011; Knardahl et al., 2017; Wilson et al., 2020). On the other hand, EWL may have neutral or even beneficial health effects when working part-time but may also have adverse effects when working in a physically and

mentally demanding environment (Baxter et al., 2021). High physical demands have also been found to be associated with a lower likelihood of working beyond statutory retirement age, and a favourable psychosocial work environment with a higher such likelihood (Andersen et al, 2021). Above that, job control and high job satisfaction were associated with later retirement intentions and actual retirement, whereas the association with job demands was inconsistent (Browne et al., 2019). Against this backdrop and in the context of EWL, expanded knowledge about job quality among older workers, its structure, and work-related effects is essential. **It can be concluded for older workers, that `the benefits of work for health, however, depend on the quality of the job´ (Burdorf et al., 2023, p. 1388), and consecutive effects may be assumed for retirement timing and additional working years.**

To summarize, several vulnerabilities cumulate in older workers which require thorough consideration when it comes to EWL (c. f. Jones et al., 2013). In addition, their work environment is ascribed an important role for promoting employability (OECD, 2018b; Pohrt & Hasselhorn, 2015) but is not understood well (Ebener & Hasselhorn, 2015; Pohrt & Hasselhorn, 2015) as it is mostly investigated with focus on certain variables in isolation (e. g. d'Errico et al., 2021; Dragano & Schneider, 2011; Mäcken, 2019) or on international level (e. g. Eurofound, 2017; Ferreira et al., 2024). Concurrently, policy focus continues to lie on quantitative EWL outcomes such as effective retirement age and employment rates typically of workers aged 55+ years (Kuitto & Helmdag, 2021), whereas qualitative EWL outcomes remain inferior albeit both quantity and quality of the job were shown to vary in the same direction (Piasna, 2023). In a note on key policies to promote longer working lives in Germany, arduous or hazardous working environments were even taken into consideration to justify the introduction of specific provisions and to link full-pension eligibility to previous working conditions rather than to a fixed number of years worked (OECD, 2018b, p. 4)[2]. Such a progressive notion, however, would necessitate to identify the respective subgroups in the German workforce by specific criteria or indication with respect to their work environment (see Natali et al., 2016). However, as far as is known, such an approach does not exist to date and may be associated with a range of potential barriers (Nullmeier, 2025). **Academics critically demand policy to consider quality of work and individual work capacity when extending employment participation and working lives to assure fairness and effectiveness of future retirement regulation (Hasselhorn, 2020a).**

Ultimately, one may ask what constitutes a `good´ or a `bad´ job? From the perspective of the large group of baby boomers in Germany who are about to transition to retirement in the next years, this is unclear so far. For that reason, this dissertation strives to facilitate a differentiated understanding of the working situation of older employees in Germany by a) depicting their daily work environment in its entirety and b) thereby creating a solid starting point for the investigation of job quality risks and

[2] For an overview of that discussion see also Bäcker (2016).

potentials for health and employment in the context of EWL and retirement. Consequently, a sound concept and operationalization of job quality is required. Prior to a detailed reconstruction of its understanding followed in this thesis, the research context and the different scientific perspectives taken on job quality are outlined.

### 1.2 Interdisciplinary perspective in job quality research

Employment participation in higher working age and, consequently, retirement decision-making and exit from employment, is a complex process, where over time individual characteristics and circumstances such as health, motivation, and finances (= micro-level) interact with work and organizational domains (= meso-level) within the societal context including labour market policies and regulations (= macro-level; Hasselhorn & Apt, 2015). Following this view, job quality is located at the meso-level but linked to both the micro- and macro-level. Working conditions represent ongoing exposures in the form of the work content and environment, and may constitute either a risk or a resource in terms of their impact on health in later-life (Ardito et al., 2020; de Lange et al., 2006; Havermans et al., 2018; Mänty et al., 2015; Zoer et al., 2011) and in the retirement process (Amilon et al., 2024; d'Errico et al., 2021; Mänty et al., 2016; Matthews, 2014; Meng et al., 2017; Nilsen et al., 2022; Robroek et al., 2015; Welsh et al., 2016). Concurrently, working conditions and their individual impact also reflect the results of occupational health and safety regulations and government policies, so that associations between job quality and the individual worker need to be interpreted against this background (Hasselhorn & Apt, 2015). As Findlay and colleagues (2013) state, „[…] the study of job quality is an inherently multi-disciplinary enterprise" (p. 448), and as a direct consequence, several scientific disciplines converge in the investigation of its role in the context of the work-retirement transition. The resulting interdisciplinary perspective adopted in this thesis include that of *Occupational Health Science*, *Occupational Medicine, Sociology* and *Social Epidemiology, Work and Organizational Psychology,* and *Occupational Safety*, as each discipline adds to the understanding of quality of work itself and/or its differential effects and implications on the respective level of analysis. Each discipline will be outlined briefly in the following.

Occupational Health Science (German: Arbeitswissenschaft) is a recent discipline in Germany that can be compared internationally with Ergonomics and Human Factors. Its objective is to analyze, categorize, and design work processes in its technical, organizational, and social requirements to derive design principles for work processes that are feasible, tolerable, endurable, and safe. In addition, work should allow for the retention and development of discretion, skills, and personality (Schlick et al., 2018). The work environment and the characteristics of the work tasks are immanent to this definition, so that Occupational Health Science may serve as a basis in the understanding of the working situation of baby boomers in the work-retirement transition.

Occupational Medicine deals with the promotion, preservation, and restoration of work ability, employability, and health (Schlick et al., 2018). In contrast to Occupational Health Science, the focus lies on the investigation and evaluation of physical, psychological, and social consequences of work and the work environment, and is, above that, concerned with preventive objectives. An Occupational Medicine perspective serves particularly in the evaluation of health-related consequences that may be associated with working conditions of older employees as well as in deriving potential adaptations of the working situation that enable older employees for work.

In Sociology, a central interest lies on the working individual, his or her specific working situation, and the role as part of a social system in the context of the workplace. Consequently, social relationships of employees, their working and employment conditions, changes of organizational structures, job satisfaction and work motivation, the work system itself, and workplace design are observed and analyzed (Schlick et al., 2018). This is closely linked to Social Epidemiology, which deals with socially and economically determined (dis)advantages and its relation to health differences in the population (Honjo, 2004). In the context of later-life work and employment, both disciplines complement the perspective taken in this thesis, as – particularly in times of EWL – working conditions, their distribution among older working age groups, and their differential association with health are of high individual, organizational, and political relevance.

Work and Organizational Psychology is concerned with studying the individual at the workplace and in organizations, its psychological development over working life-course, and underlying determinants. Of particular interest are the workers´ experience and behaviour and its dependence on working conditions, work task, and prerequisites for work performance. Accordingly, the subject matter includes the working individuals´ motives, needs, goals, and plans in this context (Schlick et al., 2018). Addressing a psychological perspective in the investigation of job quality is important, as younger and older working age groups may differ their work environments. Consecutively, their motivations and goals may also diverge after decades of differential workplace exposure, specifically in a working life-stage normatively concerned with the transition to retirement (Kanfer et al., 2013).

Finally, in Germany, Occupational Safety is grounded in the German Occupational Safety and Health Act („Arbeitsschutzgesetz“ [ArbSchG]: Gesetz über die Durchführung von Maßnahmen des Arbeitsschutzes zur Verbesserung der Sicherheit und des Gesundheitsschutzes der Beschäftigten bei der Arbeit, 1996), which aims to maintain and improve safety and health protection in the workplace. It stresses the responsibilities of both employers and employees in avoiding work-related, physical and mental harm and in maintaining work ability. This Act states explicitly in §5, that employers must evaluate working conditions regarding potential hazards in the form of workplace design, physical, chemical and biological exposure, means of production, work processes, employee qualification, and instruction as well as psychological strain. Thus, the investigation of working conditions, their main

dimensions, and their direct health-related impact are also legally informed, and benchmarks for the evaluation of the work environment of older employees are indirectly preset.

### 1.3 What is job quality?

Job quality is a research subject in many scientific disciplines (Achatz & Gundert, 2017; Hauff & Kirchner, 2014). It has been applied widely in international policy, with varying bandwidth in content and sometimes with questionable validity (Piasna et al., 2019). However, „the meaning attributed to job quality will be different depending on whether it is viewed from the standpoint of individual workers, families, employers or from a societal perspective" (p. 176). Concerning the scope of this thesis, its concept will be approached predominantly from an Occupational Health Science and psychological perspective, and on the operational level from the perspective of the individual worker (1.3.3). In doing so, special attention will be given to conceptualizations which target specific characteristics of the job somehow, thus allowing for an indication of the direction for improvement.

#### 1.3.1 Conceptual approaches

Although the study of job quality dates back many decades (e. g. Davis & Taylor, 1972), no definite consensus exists on what constitutes it, as it is „very much a contextual phenomenon, differing among persons, occupations and labour market segments, societies and historical periods" (Findlay et al., 2013, p. 448). Be it from an economical, sociological, or psychological point of view, it is agreed upon that the job not only serves in the provision of financial resources, but also in the fulfillment of psychosocial needs in the form of security, status, appreciation, autonomy, and social integration (Achatz & Gundert, 2017). **At the broadest level, job quality „can be defined as the extent to which a job has work and employment-related factors that foster beneficial outcomes for the employee, particularly psychological well-being, physical well-being and positive attitudes such as job satisfaction" (Holman, 2013, p. 476).**

The quality of a job is closely linked to research in the field of work stress, where demands and (lacking) resources in the work environment are understood as stress-inducing stimuli – both with a cognitive, emotional, and physical component – and investigated in this sense (Le Blanc et al., 2008). Stressors in the form of job demands refer to work-environmental stimuli that „require sustained cognitive, emotional and/or physical effort and include workload, emotional labour and physical exertion" (Le Blanc et al., 2008, p. 121). Job resources, on the other hand, are „broadly conceptualized as a kind of energetic reservoir tapped when the individual has to cope with stressful stimuli" (p. 121), and may comprise job variety, social support, or ergonomic aids (Le Blanc et al., 2008). As a consequence, lack of the latter would likewise represent stressors in the form of monotonous work, low social support, or adverse work posture, for which an individual needs to deplete resources to adapt to these work-environmental circumstances. A non-exhaustive overview of basic categories of job-related stressors is given in Table 1.

Table 1

*Categories of job-related stressors (from Le Blanc et al., 2000)*

| Category | Stressor |
|---|---|
| Job-content | work over-/underload |
| | complex work |
| | monotonous work |
| | too much responsibility |
| | dangerous work |
| Physical, ambient and ergonomic working conditions | toxic substances |
| | noise, vibrations, lighting, radiation, temperature |
| | adverse work posture |
| | physically demanding work |
| | dangerous situations |
| | lack of hygiene |
| | lack of protective devices |
| Employment conditions | shift work |
| | low pay |
| | poor career prospects |
| | flexible labour contract |
| | job insecurity |
| Social relations at work | poor leadership |
| | low social support |
| | low participation in decision-making |
| | liberties |
| | discrimination |

In work stress research, the evaluative and physiological response of an organism to a dangerous or threatening stimulus is viewed as stress and the associated outcome is referred to as job-related strain (Le Blanc et al., 2008). These stress reactions in the form of strain can vary in intensity, and if timely stress reduction is not accomplished by means of relief, recreation, or relaxation, prolonged exposure to stressful stimuli can manifest in an affective, cognitive, physical, behavioral, or motivational strain on the individual, interpersonal, or organizational level (Le Blanc et al., 2008). Table 2 gives a non-exhaustive overview of work stress types by level of expression. **Following these remarks, work stress is understood as „the experienced incongruence between job demands and job or individual resources that is accompanied by cognitive, emotional, physical or behavioral symptoms" (Le Blanc et al., 2008, p. 124).**

Table 2

*Stress symptoms by level of expression (from Le Blanc et al., 2008)*

| | Level of expression | | |
|---|---|---|---|
| Type of stress | Individual | Interpersonal | Organizational |
| Affective | anxiety<br>tension<br>anger<br>depressed mood<br>apathy | irritability<br>being oversensitive | job dissatisfaction |
| Cognitive | helpless-/powerlessness<br>cognitive impairments<br>difficulties in decision-making | hostility<br>suspicion<br>projection | cynicism about work role<br>not feeling appreciated<br>distrust in peers, supervisors and management |
| Physical | physical distress (headache, nausea, etc.)<br>psychosomatic disorders (gastric-intestinal disorders, coronary diseases, etc.)<br>impairment of immune system<br>changes in hormone levels | | |
| Behavioral | hyperactivity<br>impulsivity<br>increased consumption of stimulants (caffeine, tobacco) and illicit drugs<br>over-/undereating | violent outbursts<br>aggressive behavior<br>interpersonal conflicts<br>social isolation/withdrawal | poor work performance<br>declined productivity<br>tardiness<br>turnover<br>increased sick leave<br>poor time management |
| Motivational | loss of zeal<br>loss of enthusiasm<br>disillusionment<br>disappointment<br>boredom<br>demoralization | loss of interest in others<br>indifference<br>discouragement | loss of work motivation<br>resistance to go to work<br>dampening of work initiative<br>low morale |

Although the negative aspects of work stress have been researched more extensively in the past (see Mark & Smith, 2008), scientists have also been theorizing from the very beginning of work stress research about positive stress effects, its determinants, and prerequisites (for an overview and critical

discussion see Kupriyanov & Zhdanov, 2014). This led to the distinction between `distress´ as a negative response associated with a decrease in adaptive capabilities as defined above and `eustress´ as a positive response to a stimulus or situation that initiates an increase in these capabilities (Kupriyanov & Zhdanov, 2014). Influenced through studies in the field of human resiliency, Occupational Health Psychology has begun to establish and investigate the concept of `work engagement´ as a form of eustress, to understand better those employees, who are observably connected with their work activities and who experience „a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption" (Le Blanc et al., 2008, p. 125). As might be expected, engagement at work is related to the availability of psychosocial job resources and is therefore more strongly associated with motivational than with health outcomes (Bakker et al., 2014). In contrast to the strain symptoms depicted in Table 2, work engagement outcomes comprise among many others higher affective and job commitment, better life satisfaction and work ability, better in-role and extra-role performance, and lesser turnover intentions as well (Kossyva et al., 2023), and may in turn enable employees for further resource accumulation – as was found among older employees when investigating their retirement timing (Frins et al., 2016; Schreurs et al., 2011). **It follows immediately from this initial account, that the quality of the job may very likely comprise multiple demands and resources from different domains which do not necessarily need to be interdependent, and that the associated effects can manifest on the individual, interpersonal and organizational level.**

Theoretical models addressing the relationship of work characteristics with health and well-being in the form of work stress were conceptualized since the 1960s (Mark & Smith, 2008), with the social-psychological `Michigan Stress Model´ (French & Caplan, 1972) being the first to recognize workload, job control, and workplace social support as occupational exposures accountable for it. Succeeding models addressed the balance between job demands and job control (Karasek, 1979) or the fit between individual and work-environmental characteristics (Edwards, 1991; Edwards & Shipp, 2007) as a source of job-related stress. Later models expanded them in light of evidence suggesting that e. g. workplace social support buffers the interaction between high demands and low job control (Karasek & Theorell, 1990) or focused a specific balance aspect in the transaction[3] between the individual and job characteristics (Siegrist, 1996, 1998). Recent developments integrated prior models with the aim to specify the relationship of certain job demands with health and well-being, and to increase the predictive power concerning different strain and engagement outcomes (de Jonge & Dormann, 2003; van Veldhoven et al., 2005). A promising advancement was made with the `Job Demands-Resources´ Model, which expands the model by Karasek and Theorell (1990) through the consideration of multiple resources each from the physical, psychological, social, and organizational

[3] See Mark and Smith (2008) for further transactional work-stress models.

domain in the interaction of job demands and resources (Demerouti et al., 2001). As hypothesized by the model and confirmed by a large body of evidence, job demands are linked with well-being through a health impairment process and job resources with engagement through a motivational enhancement process. Above that, resource-richness has been proved to reduce the negative impact of high job demands on employee health and engagement, thus qualifying the model as a heuristic framework applicable to many occupational environments (Mark & Smith, 2008).

Besides the exiting questionnaires or systematized measurement tools to assess (dimensions of) the above models for scientific research purposes (Landsbergis & Theorell, 2000), policy interest in the assessment of job quality has grown since the introduction of the `ILO Decent Work Agenda´ (Sengenberger, 2001), particularly aiming for the measurement, cross-national monitoring, and evaluation of job quality (see Muñoz de Bustillo et al., 2009; c. f. also Green et al., 2024). Owed to its multidimensional character, several frameworks with indicators of varying content and underlying predictors had been developed and applied since (Cazes et al., 2015; Muñoz de Bustillo et al., 2009). The three most established frameworks on international level with a certain focus on the work environment will be outlined briefly in the following.

One important initiative to the assessment of job quality on EU level was made by the „European Trade Union Institute (ETUI)" in developing a *European job quality index* to overcome limitations by previous (inter)national approaches concerning divergences in feature selection, content variability, cross-national comparability, and periodicity (Leschke et al., 2008). This measure, drawing from individual level data from multiple established sources such as the European Working Conditions Survey or the EU Labour Force Survey, focuses on the individual worker perspective and is compiled on the six indices *income quality, forms of employment and job security, working time and working life balance, working conditions, skills and career development,* and *collective interest representation and voice.* The last update was with 2021 data (Piasna, 2023). Each index is calculated across several items and sub-dimensions and presented either as a single measure or as an equally contributing component of a combined, overall job quality index (Leschke et al., 2008; Piasna, 2023). Besides proposing a comprehensive approach to the measurement and monitoring of job quality across the 27 EU member states, this index aims to provide policy with specific directions for job quality change (Piasna, 2023).

The OECD proposed a *Framework for Measuring and Assessing Job Quality*, that focusses on job quality outcomes that are explicitly relevant for the well-being of employees on the individual level, thereby aiming to foster the international comparability of job quality across socio-demographic groups and over time (Cazes et al., 2015). This framework also follows a multidimensional approach and considers three broad indices in isolation for the depiction of job quality – each through objective features. These indices are *earnings quality, labour market security,* and *quality of the work environment.* Each index is operationalized along a specific set of `headline indicators´ (e. g. `job strain´

by means of the relation of job demands and resources as a headline indicator for `quality of the work environment´) as well as supplementary indicators all required to fulfill pre-defined measurement principles by the OECD and other a priori-set criteria (Cazes et al., 2015, p. 21). Data for index calculation is obtained from the OECD database as well as from established sources such as the European Working Conditions Survey or the International Social Survey Program. The OECD Job Quality Framework follows a double objective as it considers job quality as a means for better economic performance in quantitative and qualitative terms, and also as a determinant of well-being at the workplace (Cazes et al., 2015).

A third framework is proposed by the „European Foundation for the Improvement of Living and Working Conditions" (Eurofound), where job quality is assessed at the job level and from the perspective of the individual worker. Formerly spanning four dimensions in isolation, it focusses on essential job features that `meet workers needs for good work´ (Eurofound, 2012, 2015). In the meantime, it has been expanded to seven dimensions that have been shown to have a causal positive or negative impact on health and well-being, and which capture individual working and employment conditions (Eurofound, 2017). These dimensions widely cover intrinsic job features condensed in indices of the *physical environment, work intensity, skills and discretion,* and the *social environment,* an index of *working time quality,* as well as extrinsic features captured in indices of *earnings* and *prospects*. The respective indices themselves comprise a multitude of sub-dimensions, for instance, the skills and discretion index comprises a cognitive dimension, decision latitude, organizational participation, and training (Eurofound, 2017). The European Working Conditions Survey is used as the main data source. A distinguishing feature of Eurofound´s framework is the clustering of jobs along the seven indices mentioned in order to identify workers with similar overall work exposure patterns. In this way, Eurofound grouped workers into five distinct profiles of varying prevalence in the European workforce, each associated with specific risks and potentials (Eurofound, 2017). Overall, the framework „aims to measure working conditions across European countries, analyse the relationships between different aspects of these, identify groups at risk, highlight issues of concern and areas of progress and, ultimately, contribute to developing EU policy aimed at improving job quality" (Eurofound, 2017, p. 8) – particularly through input in the form of job quality profiles for targeted policies. In a recent research report, the challenges associated with the retention of older workers in the workforce were specifically addressed (Eurofound, 2025).

It is essential to reason on how job quality needs to be operationalized so that every older employee in Germany considers his or her work environment depicted adequately. In synopsis with the frameworks outlined above, none of them appears to fit automatically to every national labour market and working population without proper adjustment. Concerning the baby boomer generation in Germany, more evidence on work factors and their role in Germany is needed (Ebener & Hasselhorn,

2015), especially as a multitude of them is of particular importance for retirement timing (see Scharn et al. 2018). Here, the conceptual approach of Eurofound's job quality framework may be most appropriate, as it has the potential to capture the working situation from the perspective of baby boomers and with the widest content width, thereby allowing for a valid estimation of job quality effects on health and employment in the last working years.

### 1.3.2 Operational considerations

In occupational stress research, regardless of the underlying theoretical foundation, a general distinction in the assessment of work characteristics is made between `objective´ features that are assumed to reflect objective reality as well as their `subjective´ appraisal, which includes cognitive and emotional processing and, consecutively, personal judgement of objective characteristics (Frese & Zapf, 1994). Objective characteristics can be assessed directly through characteristics of the contractual relationship itself and may include for instance job tenure, working time, or earnings (Hauff & Kirchner, 2013, p. 339). The choice of objective characteristics assumed to be relevant for the constitution of job quality is nonetheless theory-informed (Muñoz de Bustillo et al., 2011), and not all working- and employment conditions deemed critical can be assessed in a likewise manner. It must be considered that their individual perception and appraisal might deviate substantially from objective characteristics thus influencing the evaluation of the overall job quality. Accordingly, job security or job satisfaction are better assessed through subjective evaluations of the working situation (Hauff & Kirchner, 2013, p. 339). However, the validity of subjective data can also be criticized as individuals may be affected by personal expectations or preferences that prevent a realistic appraisal of the given characteristics, circumstances, or the work environment as a whole (Achatz & Gundert, 2017; Freese & Zapf, 1988). Studies addressing research questions concerning job quality give varying importance to the use of objective, subjective, or both types of indicators for that reason (Muñoz de Bustillo et al., 2011, p. 466). When investigating job quality from an occupational health perspective as in the present thesis, special emphasis is given to objective characteristics describing work content and organizational framework conditions and their impact on health and employment participation (Schlick et al., 2018).

### 1.3.3 Variable-centred vs. person-centred analysis approach

Research questions in occupational health generally have focused on the investigation of single exposure types and its effects on outcomes such as health (e. g. Niedhammer et al., 2021) and employment in a population of interest (Browne et al., 2019; Knardahl et al., 2017; see also section 1.4.1). This traditional approach in the social sciences, the so-called *variable-centred* analysis approach, strives to explain the respective associations in a sample that is assumed to be homogeneous (Howard & Hoffman, 2018, p. 848). Typical analytical methods are based on the general linear model including among many others analysis of variances, regression analyses and correlation. Exemplary research questions e. g. addressed in retirement research in such a manner are the effects

of – particularly physically demanding – working conditions as a risk of early exit from work (e. g. d´Errico et al., 2021; Dragano & Schneider, 2011), the impact of retirement on age-related cognitive decline (e. g. Meng et al., 2017), or typically in occupational epidemiology, by investigating the association of psychosocial work exposures with various health outcomes as was done by Niedhammer et al. in a meta-review with meta-analysis in 2021. This approach has its major strength when it comes to parsimony as common associations in an entire sample are detected and described by a single set of parameters allowing for a straightforward interpretation (Howard & Hoffman, 2018). It may also be advantageous when the identification of risk factors in e. g. certain work contexts or populations is aimed for (Burns et al., 2016; Mäcken, 2019; Welsh et al., 2016). A limitation can be seen in its low specificity: when describing the association of variables with a single set of parameters, the variation between individuals concerning that relationship is per definition set to zero. The adjunct assumption of sample homogeneity can also be debated, as it may seldomly apply to all populations in such strictness (McLachlan et al., 2019). In addition, single physical and psychosocial work factors can be substantially correlated. This may bias the distinctiveness of the respective associations (d´Errico et al., 2021), and the effects found a specific work factor may partially be attributed to unmeasured but correlated characteristics (Knardahl et al., 2017). **To overcome the mentioned limitations, it may be important to simultaneously analyze the entire work environment of the target working population with respect to characteristic features of the labour market of interest.**

An improvement of the measurement of working conditions with respect to typical exposure clusters has been demanded consequently e. g. by Burgard and Lin already more than ten years ago (2013, p. 11). In recent years, occupational epidemiology has begun to adopt a person-centred exposure perspective, thereby allowing for a more holistic evaluation of work environments and the synergistic effects on the individual (c. f. Bouwens et al., 2024; Bujacz et al., 2018, 2021; Eurofound, 2017; Gut et al., 2024; Jonsson et al., 2021; Vanroelen et al., 2010). This approach is subsumed under the term *person-centred* analysis approach and is mainly characterized by the purpose to determine and describe the optimal number of subgroups of similar individuals in a population along a pre-selected set of common indicator variables. A further aim may be the analysis of subgroup membership with certain outcomes of interest or the movement between the subgroups over time (Howard & Hoffman, 2018)[4]. Accordingly, the sample under investigation is assumed to be heterogeneous. Typical analytical methods include finite mixture modelling techniques such as latent class-, latent profile-, or latent transition analysis (Lazarsfeld & Henry, 1968; McLachlan et al., 2019). One main application area are research questions assuming group structure in the data or scenarios where it is indicated to

[4] For reasons of completeness, the *person-specific* analysis approach should also be mentioned, which aims to explain the relationship of specific variables in a given individual, thus yielding the most specific and most complex results (Howard & Hoffman, 2018).

explore the data for it (McLachlan et al., 2019), as was done e. g. by Vanroelen et al. (2010) in Belgium or on EU level by Eurofound (2017). Exemplary research questions, for instance in occupational health research, may involve the identification and classification of vulnerable workers on the basis of working conditions and educational level, and differences concerning subgroup membership and burnout symptoms (Bouwens et al., 2024). Or in retirement research, where the interest may lie on the identification and classification of job resource profiles and their association with multiple health measures among older workers (Gut et al., 2024). A main strength of the person-centred analysis approach is the simultaneous assessment of multiple job characteristics and the identification of typical exposure patterns including their prevalence in a working population (e. g. Bujacz et al., 2018; Eurofound, 2017; Vanroelen et al., 2010). This is closely linked to a higher degree of specificity provided in the description of individuals. Against the backdrop of a working lifespan, it is highly probable that selection processes shape and consolidate group patterns in the workforce, and that these are more pronounced in higher working age (Amick et al., 2016; Dannefer, 2003). Above that, when investigating work environments in later working life and their role for EWL, this approach also allows to address better the demand for an improved measurement of working conditions, which includes their change over time, exposure accumulation, and lagged health effects of workplace exposure (Burgard & Lin, 2013). A limitation associated with this approach is the identification process of an optimal number of profiles and their substantial interpretability. This is owed to a higher complexity due to the multiple parameters produced, complicating a straight-forward interpretation of the final solution. Accordingly, a more confirmatory application is pleaded for to enhance plausibility of the results. In addition, the subgroups identified need to be checked for stability and validity (Bacher & Vermunt, 2010).

Both approaches, the variable-centred- and the person-centred approach, have their strengths and typical areas of application. In the context of this thesis, however, the latter approach appears particularly suitable: it considers the multidimensionality of job quality in a population where subgroups may exist as a result of life-long workplace exposure and selection dynamics. **The person-centred analysis approach has the potential to capture explicitly the work exposure perspective of the working individual in the work-retirement transition.**

### 1.4 How does job quality affect older workers?

In the following, empirical findings regarding the role of work exposure for health and employment across later working life will be focused (section 1.4.1), with special attention given to findings exclusively considering older workers in Germany (1.4.2). The section closes with the consequential research gap addressed in this thesis (1.4.3). But when are workers `old´? In order to facilitate the interpretation of empirical work exposure effects, it is necessary to outline the conceptualization of `older workers´ first and the mechanisms relevant in the context of working-life exposure as well.

The categorization of age groups varies widely across studies in a range of working age spanning typically 16-65 years (Waddell & Burton, 2006, p. 6). It is a common conceptual problem that specific cut-off years may be appropriate for certain age groups of the working population in a specific country, but likewise fail to depict structural characteristics of other national labour markets – be it within or outside the EU. Consequently, in international studies, working individuals are inconsistently categorized as `older workers´ starting from 40+, 45+, 50+ years, or not until 55+ or even 60+ years, so that no universal definition of `older worker´ can be given initially (Farrow & Reynolds, 2012, p. 5; Wegman & McGee, 2004). The categorization of younger-to-middle-aged workers varies in correspondence. Concerning the German labour market, the baby boom years spanned a rather short time frame compared to other Western countries and covered the years 1955-1970 (see Tisch & Tophoven, 2011). The birth cohorts studied in this thesis (see Hasselhorn et al., 2014) are of particular importance for the investigation of the work-retirement transition in Germany, as the 1959 cohort marks the first high-birthrate age group of the German baby boom and the 1965 cohort – still a high-birthrate age group – the first drop in birthrate during the baby boom (Tisch & Tophoven, 2011). Both cohorts mentioned are on the threshold of higher working age by the first time they were followed prospectively (Hasselhorn et al., 2014). This allows for the detection of later-life work-environmental exposure effects and critical periods for interventions, as male employees in Germany aged 35-44 years and female employees aged 45-54 years begin to report a significantly higher prevalence of poor self-rated, general health compared to younger age groups (Burr et al., 2013). According to the German Federal Employment Agency, workers aged 45+ years also begin to have a lowered employability and have a higher risk of labour market exclusion in comparison to younger working age groups, so that measures for the maintenance or promotion of employability target individuals of that cut-off age (Dauth & Toomet, 2016). **A cut-off age of 45+ years might therefore be appropriate to conceptualize older workers on the German labour market.**

Life-long work exposure has a clear impact on higher-age well-being and quality of retirement (Nilsen et al., 2022; Wegman & McGee, 2004). It appears necessary, therefore, to adopt a life-span view that addresses influential processes for outcomes in higher working age (Baltes et al., 2012), in order to reflect a worker´s factual exposure experience across the life-course adequately (Amick et al., 2016). Kendig and Nazroo (2016) differentiate three mechanisms in this regard, namely *critical periods, accumulation,* and *pathways*. Each will be outlined briefly. *Critical periods* are understood as `sensitive phases´ in the life course in which occurring factors have an irreversible impact that consecutively determine later outcomes. In the context of this thesis, the work-retirement transition can be understood as such a sensitive phase, where timing and magnitude of certain characteristics determine whether individuals manage to adjust well to their exit from the workforce (c. f. Hasselhorn, 2020a). *Accumulation*, by contrast, describes the way in which cumulative work exposures over the

life-course – regardless of timing – may influence outcomes at a later life-stage (Kendig & Nazroo, 2016). For instance, such a mechanism may operate in the association of accumulated, intellectually stimulating work throughout the working career with higher levels of successful ageing at 70+ years, whereas accumulation of adverse work exposures is associated in the opposite direction (Nilsen et al., 2022). This mechanism may explain why some individuals are socially more advantaged than others during working life and particularly at its end (c. f. Dannefer, 2003). Finally, Kendig and Nazroo (2016) specify *pathways* as a third mechanism, which can be understood as mediators in the association of circumstances or exposures early in working life with outcomes in later life-course. In the context of EWL and retirement, such a mediator may be the health status in the association of adverse working conditions with early, ill-health exit from employment (e. g. d'Errico et al., 2021; Dragano & Schneider, 2011; Knardahl et al., 2017; Schram et al., 2020; Söderberg et al., 2021; van Zon et al., 2022), or work-related motivation in the association of life-long work exposure with (timing and quality of) retirement (Hasselhorn & Ebener, 2018). Besides its explanatory value in general, such a mechanism proves additionally useful as it also points at potential targets for interventions to improve employability through e. g. workplace accommodations aiming for health enhancement (c. f. Browne et al., 2019).

It must be considered, that – independent from these three mechanisms – work environments themselves can change across the course of time, with incremental effects on certain parts of the working population. In this sense, Corin et al. (2021) investigated more than 110.00 observations of the full range of working age in Sweden between 1997-2015 and found overall stability of working conditions across all occupations, but a high degree of heterogeneity of the development of working conditions for certain occupations. This emphasizes that the workforce might comprise homogeneous subgroups with deviating exposure patterns, and that certain occupational groups might experience additional adversity through historic changes of work environments. As already stressed by academics, EWL policies argue with the increase in life-expectancy for additional working years to unburden national social security systems, but in doing so, they set a privileged working life-course as the norm. It is debatable though, whether such a view on the working population – and analogously on the German one – reflects their actual work exposure experiences and factual capabilities to adapt uniformly to more years in work (Krekula & Vickerstaff, 2020). **For a full understanding of work exposure across working life, it is necessary to see the large collective of older workers as a heterogenous group with differences in health and longevity resulting from diverging exposure patterns and the herewith associated, accumulated (dis)advantages (Krekula & Vickerstaff, 2020).**

### 1.4.1 Work exposure effects on health and employment – international findings

The impact of work-environmental factors on health and well-being outcomes has been researched extensively over the past decades, so that numerous reviews with meta-analyses (e. g. Burgard & Lin, 2013; Dragano et al., 2017; Kaltenegger et al., 2021; Pena-Gralle et al., 2021; Theorell et al., 2015) or

even meta-reviews (Niedhammer et al., 2021) are available by now on data obtained from international studies – with research activity centred in Scandinavian countries. Such publications focus on global associations where age is controlled for statistically (c. f. Knardahl et al., 2017), albeit leaving it unanswered, whether the impact of specific work exposures on health and employment outcomes is absent, present, or pronounced among higher working age groups.

But how are older workers affected by their work environment then? Interest in the age-specific investigation of working conditions developed hesitantly. In one instance, de Lange et al. (2006) demonstrated in a Dutch sample, that low social support from colleagues and the supervisor, respectively, predicted emotional exhaustion only among workers aged >50 years and high job demands predicted emotional exhaustion only among workers aged 35-50. Such primary findings are of high importance, as the associations found may have cancelled each other out when analyzed across all age groups (de Lange et al., 2006). In a likewise manner, a cross-sectional study differentiated four age groups in more than 800 employees of a Dutch railway company and found high emotional workload as a specific risk factor for mental health complaints among employees aged 22-35 years, but poor social support – from colleagues or the supervisor – as risk factors among those aged 46-55 and 56-66 years (Zoer et al., 2011). Unfortunately, further studies contrasting different working age groups in their analyses are still sparse (Hasselhorn et al., 2013, p. 337).

Instead, research activities directly targeting working conditions of older age groups have gained momentum, so that in a recent scoping review covering 23 international studies, Amilon et al. (2024) identified adverse physical and psychosocial working conditions as one main influence of mental well-being among older workers approaching retirement. Few studies even addressed continuity and change effects of later-life work exposure. In this respect, a study by Mänty et al. (2015) included assessments from 2002, 2007, and 2012 in their analyses of nearly 2.800 municipal employees from Helsinki aged 40, 45, 50, or 55 years at baseline. They found continuity and increase of adverse physical working conditions to be associated with a decline in physical health over time and that a decrease in such exposure reduced this decline. Of the psychosocial work exposures, decreased job control was associated with greater physical health decline and constant high or increased job control reduced this decline (Mänty et al., 2015). Even though focusing on a limited set of exposure characteristics, such findings stress the role of certain work environmental features for later-life physical health in a vulnerable age group, and address exposure accumulation that may be accountable for health variability over time. On the other hand, Havermans et al. (2018) – when analyzing a Dutch sample of roughly 5.300 employees – found evidence for better mental health over time when workers aged 45-54 and 55-65 years were exposed to improved psychosocial working conditions, compared to those with constant adverse exposure. **At that point, there is initial evidence suggesting associations of**

**specific work environments with physical and mental health that diverge from younger working age groups, and that job quality may alter those health effects over time.**

When transferring this evidence to the EWL context, the risks and potentials associated with additional working years in certain work environments require critical examination. It first needs to be considered that forcing the older workforce to postpone retirement may exacerbate the adverse physical and mental health effects found for poor job quality among certain groups (Welsh et al., 2016). In fact, Ardito et al. (2020) causally verified such a detrimental health effect of EWL among roughly 95.000 Italian retirees: a one-year-postponement of statutory retirement was associated with an increased incidence of hospitalization for cardiovascular diseases at 68-70 years by 2.4 percentage points, however, only for those with an adverse work environment and poor health before retirement. Conceptually similar results were obtained concerning physical (Carrino et al., 2020; Mänty et al., 2016) and mental health as outcomes (Carrino et al., 2020; Fleischmann et al., 2020). Poor job quality also affects work motivation and early exit from the workforce as was demonstrated by Böckerman and Ilmakunnas (2020). They were able to show in the Finnish working population aged 53-63 years that adverse physical working conditions were associated with low job satisfaction, which in turn was related to increased early retirement intentions, and these, ultimately, were associated with consecutive earlier retirement as indicated by register data. Comparable findings were obtained for retirement planning and decision-making (Topa et al., 2009) as well as job quality accumulation and its expected impact on desired retirement age (Frins et al., 2016). Even though not of causal nature, these results demonstrate the crucial role of work-environmental characteristics and work motivation for disparities in later-life employment participation as well as in the retirement process (Hasselhorn & Ebener, 2018; Krekula & Vickerstaff, 2020). **It can be concluded, that work contexts typically characterized by strain and adversity might impede extended employment careers through work-motivational and health impairments.**

On the other hand, the change of an entire work environment – particularly at 55 years of age – may have positive health consequences when considering employment participation in the pre-retirement years, as was found among Swedish construction workers changing to industries with less-straining working conditions (Söderberg et al., 2021). Further recent studies in higher working age broaden the understanding of positive exposure effects on later-life employment and retirement (Knardahl et al., 2017), as additional working years in favourable work environments may likewise constitute a resource (e. g. Matthews, 2014; Meng et al., 2017). Browne et al. (2019), when systematically reviewing 46 cross-sectional and longitudinal studies, found high job satisfaction and job control, and to a moderate degree, social support to be associated with later retirement intentions and later actual retirement age. The role of job demands was, however, only illustrated in the mentioned direction for retirement intentions (Browne et al., 2019). Also in this regard, Stengård and

colleagues (2021) investigated in a Swedish sample of 6.000 workers aged >58 years the impact of 16 psychosocial work characteristics on working for additional years in a two-year follow-up and found ten characteristics to be significantly associated. The strength of association between specific resources - namely skill-use, work-time control, reward, and low ERI – and additional working years increased with age. It might be assumed that these characteristics gain importance in the context of EWL due to their compensatory function with increasing age (Stengård et al., 2021), however, more likely for individuals in physically and mentally less demanding occupations (as indicated by Matthews, 2014). Finally, Andersen et al. (2021) investigated nearly 5.900 Danish individuals aged 55-59 years and followed them until the age of 66 years. They found a favourable psychosocial work environment to be associated with working beyond statutory retirement age, whereas a physically demanding work environment was not. Baxter et al. (2021) put into perspective the issue of EWL as a resource in a recent review, finding that the neutral or beneficial effect of EWL particularly on physical health applies most likely for males, those with part-time work and in jobs `not of poor quality.´ **Thus, „exposures to good jobs throughout the life-course not only help workers to remain longer at work, but also seem to play a crucial role in determining the size and the direction of the effects of retirement on health" (Ardito & Fleischmann, 2023, p. 171).**

### 1.4.2 Work exposure effects in the German working population

Considering that the labour force in Germany is forecasted to decrease from 45.500.000 in 2014 to 39.500.000 until the year 2060 (Fuchs et al., 2018)[5], the question arises whether national research activity on the role of work environments reflects the pressing consequences of this demographic trend. By the year 2015, only two empirical studies existed concerning the role of working conditions in the context of retirement and EWL (see Hasselhorn & Apt, 2015), and since then research based on German data was hardly published. A brief overview on this research activity will be given below.

One case-control study by Bödeker and colleagues from 2008 aimed to assess the exposure-associated risks of health-related early retirement in Germany and made use of job-exposure-matrices to operationalize workload in a sample aged 40-60 years among nearly 30.000 cases and 270.000 controls. They found low job control to pose by far the highest risk of disability retirement. Other factors found to be of significance were typical characteristics from the physical and hazards exposure domain just as in international studies (Bödeker et al., 2008). Next, using representative Micro Census data from 2001-2007, Brussig (2010) analyzed proportional employment participation and size of occupational classes among cohorts born 1934, 1939, 1944, and 1949. Over time, he found participation rates among low-skilled and skilled manual occupations to be lowest, and, just as in Bödeker et al. (2008), the findings suggest that early exit from employment may be attributable to

[5] Equaling a decline of labour supply by ~13%.

health consequences of job-related strain. However, this can only be concluded indirectly from the occupational categorization, and it might likely be the case that two individuals from the same occupation or occupational class – on average assumed to be exposed to identical work-environmental strains and risks – differ substantially with respect to job quality concerning the constellation of working conditions. Next, a study by Eibich (2015), based on German data from the Socio-Economic Panel, investigated the health effects of retirement in a sample aged 55-70 years and found a causal positive effect of retirement on health and health-related behaviour. In subsequent heterogeneity analyses, retirees priorly in physically straining occupations showed an increase in physical health, which, according to Eibich (2015), indicates of relief from work-related strain. Those priorly in mentally straining occupations benefit through increased self-rated health, whereas mental health improved only among retirees priorly in non-straining occupations. It is noteworthy, that occupational strain was operationalized by constructing separate physical and mental strain scales[6] and by setting the cut-off for high strain at the 75$^{th}$ percentile. Such an approach might incorporate the idea of exposure intensity, but with no differentiation concerning specific characteristics and their typical constellation in work environments. Further, a study by Mäcken (2019) followed about 300 German individuals from 2004-2014, aged 50-65 years at baseline, and used structural equation modelling to test for a health-mediation in the association of work stress and retirement age (as indicated by register data). She found only direct effects for low job control and poor self-rated health, respectively, on lower retirement age, but no significant health-mediation. However, the association of specific work-environmental characteristics for health outcomes among older employees was confirmed in a study by Grund and Rubin (2021) in a sample of about 3.100 individuals from the representative German Study on Mental Health at Work, aged 31-60 years by the time of baseline assessment in 2012. They found an overall significant association between low job autonomy and high sickness absence, which was only present among individuals aged 46+ years (compared to age group 31-35 years). This interaction was partially mediated through job satisfaction, which, to a limited extent, confirms the results found by Böckerman and Ilmakunnas (2020) for physical work exposure in a Finnish sample. Finally, d´Errico et al. (2021), when using data of over 2.300 individuals from the same sample as Grund and Rubin (2021), identified repetitive movements to increase the risk of long-term sickness absence at follow-up in 2017, but high work pace and low role clarity to increase the risk of unemployment, and high work time control to decrease the risk of early retirement. However, these analyses were age-adjusted thus allowing no conclusion regarding workers in the pre-retirement years. An important remark made by the authors was that only high manifestations of specific work exposures were associated with the respective early exits, thus emphasizing that differently pronounced working-

[6] Using the International Standard Classification of Occupations (ISCO88) based on representative data.

environmental characteristics may interact in the overall impact of job quality on work capacity and its individual perception (see also Wöhrmann et al., 2024).

Concerning the work-motivational consequences of job quality, Ebener (2019) demonstrated with data representative for the older German workforce, that different work-related motivations can be distinguished and that both the motivation to work and the motivation to retire may affect older workers in separation when deciding to stay in the workforce or to favor early exit from employment. As implied by the findings of Grund and Rubin (2021) or Böckerman and Ilmakunnas (2020), the dependency of work-motivational outcomes from job quality needs to be considered in the health-pathway between work exposure and employment participation (Lichtenthaler & Fischbach, 2016).

**In sum, there is very few empirical evidence specifically concerning job quality and its role for the retirement transition in Germany. Only single work-environmental characteristics were investigated, mostly in cross-section and concerning early exit from employment and quality of retirement, thus mainly relying on international evidence.**

### 1.4.3 Research gap

To date, no comprehensive investigation of job quality has been conducted among employees approaching retirement age in Germany, as was previously done for the full range of working age on EU level (Eurofound, 2017), in Canada (Lowe, 2007), or for different working age groups in Sweden (Jonsson et al., 2021) and Belgium (Vanroelen et al., 2010). In addition, existing evidence on work exposures and its effects on health and higher-age labour market participation stems from Scandinavian countries for the most part and comprises varying cut-off-ages for the target working age groups, thus having limited generalisability to characteristics of the German labour market (Pohrt & Hasselhorn, 2015). As a consecutive research gap, there is lack of knowledge concerning the structure and development of later-life working conditions in Germany and on the impact of job quality continuity and change on outcomes relevant for extended employment participation such as health (e. g. Browne et al., 2019) and work-related motivation (c. f. Ebener, 2019; Wang & Shultz, 2010).

## 1.5 Aim and scope of the thesis

This thesis aims to examine job quality of older workers in Germany by providing empirical evidence for specific subgroups with different work exposure constellations and by investigating their development and exposure effects on work-related outcomes. The applied measurement approach to job quality will be discussed and characteristic features of the subgroups identified will be contrasted. The consequences associated with differential job quality exposure for health and motivation to work will then be considered with respect to the individual employment perspective and employment participation.

The scientific investigation of job quality, as outlined above, may contribute to the occupational and retirement literature in several ways. First, a representative job quality typology may broaden the

understanding of working conditions in Germany by highlighting older employees who work in environments with increased risk of poor health and well-being, and by identifying older workers with the potential for extended employment participation without additional strain and health damage. Second, by adding evidence on the exposure effects of job quality continuity and change on health, motivation to work, and employment participation. Both may advance the understanding of the retirement process and its individual outcomes.

### 1.5.1 Research questions

To shed light on the working situation of older employees in Germany, it is the aim of this thesis to characterize their job quality in its entirety, to quantify distinct groups based on typical exposure constellations, and to investigate effects of job quality exposure on health, motivation to work, and employment. In particular, the following research questions will be answered:

a) What constitutes overall job quality of older employees in Germany? Can a job quality typology be established among them? Which individuals are exposed to adverse or favourable work environments, respectively?
b) How does job quality develop in later working life? Does job quality accumulation affect the motivation to work and does the timing of job quality change moderate this association?
c) How does job quality continuity and change affect health? Do the health effects of such job quality exposure influence employment participation in the long-term? Are there direct effects of such job quality exposure on employment participation or are they health-mediated?

### 1.5.2 Data set and methods

To address empirically the above-mentioned research questions, data from the prospective lidA („leben in der Arbeit“) cohort study on work, age, health, and employment participation (Hasselhorn et al., 2014) will be used. lidA is a longitudinal observational study representative for the socially insured workforce in Germany born in 1959 and 1965 (www.lida-studie.de), aiming to investigate the interdependency of work and the work environment with health and employment participation among older employees in Germany. Participants were surveyed via computer-assisted personal interviews at their homes at each assessment. The quantitative analyses in this dissertation will be based on the first three assessment waves, spanning the years 2011 (N=6.585), 2014 (N=4.244), and 2018 (N=3.586; Schröder et al., 2013; Steinwede et al., 2015, 2018). Data of a fourth survey wave assessed in 2022/2023 is available since the year 2023 and includes a third cohort (born 1971; N=8.884; Ruiz Marcos et al., 2023) but is omitted in all analyses in the present thesis. In-depth details on the study design and the cohort profile are given in Hasselhorn et al. (2014).

The lidA sample under study covers the age ranges 46-53 years (= 1965 cohort) and 52-59 years (= 1959 cohort), thus being particularly suitable for the investigation of working- and employment

conditions and its effects in the German working population from higher working age until the pre-retirement years. Major strengths of the lidA study are its representativeness, the large sample size, and the age-homogeneous sample. The prospective cohort study design is considered gold standard in occupational epidemiology (Hasselhorn et al., 2014). Owing to its research objective, lidA provides a wide range of established measures assessing the physical and psychosocial work environment, which allow for a comprehensive operationalisation of job quality over time (c. f. Hasselhorn et al., 2014). Different health components, health conditions as well as the employment status are likewise assessed extensively in each wave, allowing longitudinal analyses to be conducted. A measure assessing the motivation to work was initially introduced in the 2018 wave.

# 2 Summary of the studies

This chapter gives a summary of all three published studies in this dissertation regarding the respective study aim, the research method, as well as the main findings. At the end of the chapter, Table 4 displays and contrasts the main findings for better comprehensibility.

## 2.1 Study I

Hasselhorn*, H. M., Stiller*, M., du Prel, J.-B., & Ebener, M. (2020). Work profiles of older employees in Germany – results from the lidA cohort study. *BMC Public Health, 20*, 1452. https://doi.org/10.1186/s12889-020-09542-3

* joint first authorship

Study I was designed by Michael Stiller and Hans Martin Hasselhorn. All analyses were performed by Michael Stiller. Michael Stiller and Hans Martin Hasselhorn have written the first draft of the manuscript, Melanie Ebener and Jean-Baptist du Prel contributed to the development of the manuscript. Hans Martin Hasselhorn, Michael Stiller, Melanie Ebener, and Jean-Baptist du Prel reviewed and revised critically the manuscript and approved the final version.

### 2.1.1 Aim

This study investigates whether a typology of profiles comprising common work exposure factors can be identified among older employees in Germany to depict validly their characteristic working situation in the last working years. With job quality as a multidimensional concept as outlined above (Eurofound, 2017), previous research has suggested that working populations are heterogenous and that different subgroups may be exposed to different work environments (e. g. Bujacz et al., 2018, 2021; Keller et al., 2017; Khawli et al., 2023; Kim et al., 2021; Lowe, 2007; van Aerden et al., 2015; Vanroelen et al., 2010). Thus, a shifted exposure perspective should be taken when investigating working- and employment conditions in later working life, which is increasingly done by adopting a person-centred analysis approach.

For this purpose, recent empirical attempts in clustering a broad range of working conditions of the European working population (Eurofound, 2017) and those in single countries such as Belgium (Vanroelen et al., 2010) and Canada (Lowe, 2007) have been reviewed with special focus on relevant work factors and the number of job quality profiles to be expected when clustering the baby boomer part of the German working population in a likewise manner. The job quality concept of Eurofound (2017) as outlined above (1.3.1) was adopted for the present analyses and expanded to represent all relevant job demands and resources of the German labour market. In total, nine characteristics were included: physical work, working time quality, work intensity, skills and discretion, social environment, quality of leadership, continued education, earnings, and prospects. The study shows how many typical

work exposure constellations in the form of job quality profiles can be identified, describes its manifestations, and displays their prevalence among older workers in Germany. It further describes the profiles by means of sociodemographic characteristics and demonstrates profile validity by means of diverging associations with work-related outcomes.

### 2.1.2 Method

The analyses focussing on profile identification were based on cross-sectional data from the first wave (in 2011; N=6.858) of the German lidA cohort study and included a total of 6.277 valid cases after stochastic regression imputation. Participants from both lidA cohorts (born 1959 or 1965) were included in the analyses, when being employed for at least 1 h/week in 2011.

For all nine characteristics constituting job quality in study I, a respective index of positive and negative job quality characteristics was constructed based on the procedure applied by Eurofound (2017) and adapted to the present set of variables. Besides different questions measuring single aspects such as e. g. the proportion of `working time spent sitting´ as in the physical exposure index, selected items from the „Effort-Reward-Imbalance Questionnaire" (ERI; Siegrist et al., 2004) and selected scales from the „Copenhagen Psychosocial Questionnaire" (COPSOQ; Nübling et al., 2006b) were included. After calculation and transformation, indices ranged from 0 (= adverse exposure) to 100 (= favourable exposure). A detailed overview of the index construction as well as weighting of each index component is given in Hasselhorn, Stiller et al. (2020, p. 4). A step-by-step explanation of the index calculation is also given in Stiller et al. (2023ab).

In analogy to the analyses of Eurofound (2017), a finite mixture modelling technique called *Latent Profile Analysis* (LPA) was conducted to identify the optimal number of job quality profiles. Here, a model is estimated based on the assumption that the association between the observable indices can be explained by a latent variable with a finite number of profiles, which represents distinct constellations of job quality index manifestations. Using the final model equation, posterior profile probabilities were computed to allow for the assignment of individuals to a certain profile by highest probability. In summary, this modelling technique addresses unobserved population heterogeneity by grouping individuals into homogeneous subgroups in the form of profile membership.

Hereafter, the following sociodemographic variables were used to characterize descriptively the subgroups assigned to each profile: sex (male/female), educational level (low/medium/high), job task requirement level (un- or semiskilled/skilled/complex/highly complex), weekly working hours (>34 h/ 20-34 h/<20 h), and occupational area (according to Paulus & Matthes, 2013). Profile validity was investigated regarding specific associations over time (waves 1 to 3; n=3.118) with physical and mental health (Short Form Health Survey [SF-12v2]; Nübling et al., 2006a), work ability (Work Ability Index [WAI]; Tuomi et al., 1998), and work-privacy-conflict (COPSOQ II – middle version; Pejtersen et al.,

2010). Mixed-design analyses of variances (ANOVAs) were conducted to test for main and interaction effects for profile assignment and assessment year.

### 2.1.3 Results

A five-profile solution emerged as the most stable and conceptually meaningful solution compared to those with more profiles (see Figure 1 in 2.4 for graphical depiction). The final job quality profiles can be described as follows: 18,7% of individuals, with predominantly manual work, were assigned to a profile called „Poor Quality" (PQ), which depicts adverse manifestations on almost all exposures. A further 30,0%, also with predominantly manual work, were assigned to the „Relaxed Manual" (RM) profile, which differed from PQ in terms of low work intensity and high social resources. The „Strained non-Manual" (SnM) profile applied to 15,5% of individuals with predominantly non-manual work, and exhibited opposite manifestations on almost all exposures compared to RM. It is characterised by adverse manifestations of prospects, social resources and work intensity, but favourable manifestations on the remaining exposures. Also with predominantly non-manual work, 32,9% of individuals were assigned to „Smooth Running" (SR), a profile with favourable manifestations on all characteristics except for high work intensity. A last group (2,9%) of predominantly non-manuals emerged across all solutions inspected during the identification process. That profile („High Flying"; HF) differed from SR mainly in terms of extremely high earnings.

Regarding sociodemographic characteristics, workers in both manual profiles (PQ, RM) were mainly low-to-medium educated and performed (un-/semi-)skilled tasks mostly in agriculture, production, logistics and safety, as well as certain services. In the non-manual profiles SnM and SR, workers had mainly medium-to-high education and performed skilled to (highly-)complex task, respectively. Full-time work was most prevalent compared to both manual profiles, and part-time work below 20h/week was least prevalent. Frequent areas of occupation were natural and IT sciences, business organisation and administration, the health care and social sector, and humanities. Workers assigned to HF were medium-to-high educated and performed (highly-)complex tasks in full-time jobs, with one out of two assigned individuals working within business organisation and administration.

Finally, systematic associations of profile assignment with all outcomes were observed. Older workers differed significantly in physical health at all three waves depending on profile assignment. The pattern can be summarised as a gradient from high to low physical health levels in correspondence to resource-rich, non-manual profiles to manual, demanding profiles (HF, SR, SnM, RM, PQ). For all profiles except HF, physical health levels decreased significantly between 2014 and 2018. Regarding mental health levels, workers in all profiles showed a dip in 2014. Above that, patterns with overall higher and similar levels were observed for SR, RM and HF as opposed to lower levels for SnM and PQ. As for work-privacy-conflict, SnM and PQ had the highest levels at all instances, yet they decreased between 2011 and 2014. By contrast, RM and SR had the lowest levels, which increased from 2011

until 2018. HF ranked between both patterns. Finally, a gradient between profiles emerged for work ability similar to that of physical health, with highest levels for HF and SR, followed by RM and SnM, and lowest levels for PQ. Work ability decreased for HF, SR and RM from 2011 until 2018, and for PQ from 2014 to 2018. For SnM, it remained nearly constant.

In conclusion, the manual PQ can be evaluated as an adverse profile and the manual RM as somewhat favourable. Among the predominantly non-manual profiles, SnM can be evaluated as adverse and SR and HF as favourable, respectively. Concerning overall job quality, a structure as represented by these profiles demonstrates the heterogeneity of the baby boomer working population in Germany and may enhance the understanding of the complexity of work exposure and its effects during later working life. Particularly in times of EWL, the five profiles may help organizations to identify and monitor groups at risk for poor health and employability outcomes at an early stage, thereby allowing for timely intervention in many respects. Regarding policy, the profiles point out to not only focus on quantitative EWL outcomes in terms of additional working years, but to give special attention to quality of work and cumulative exposure to poor work environments when considering extended working careers for all individuals in the working population.

### 2.2 Study II

Stiller, M., Garthe, N., & Hasselhorn, H. M. (2023b). Job quality trajectories among baby-boomers in Germany and their consequences for the motivation to work – results from the lidA cohort study. *Ageing & Society, 43*(7), 1638-1660. https://doi.org/10.1017/S0144686X21001343

In Study II, Michael Stiller and Hans Martin Hasselhorn designed the study. Michael Stiller performed all analyses and wrote the first draft of the manuscript. Nina Garthe and Hans Martin Hasselhorn contributed to the development of the manuscript. Michael Stiller, Nina Garthe, and Hans Martin Hasselhorn reviewed and revised critically the manuscript and approved its final version.

#### 2.2.1 Aim

In Germany, older employees prefer to retire early (Hofäcker, 2015) and retirement timing is affected differently by working- and employment conditions (Hasselhorn, 2020b). Therefore, it may be important to know, what motivates individuals `to participate in the workforce up to and beyond normative retirement age´ (Kanfer et al., 2013, p. 256). Such a „motivation to work" (MTW; Kanfer et al. (2013) may be especially relevant in the context of EWL. Accordingly, it was found that older employees with high job resources intend to retire later, and resource availability enables them for further resource accumulation. For the presence of high demands this pattern is reversed (Frins et al., 2016; Schreurs et al., 2011). Such studies imply that job quality accumulation may be associated with MTW differences in the last working years, but do not investigate effects of job quality change systematically (e. g. Frins et al., 2016; Lichtenthaler & Fischbach, 2016; Polat et al., 2017; Schreurs et

al., 2011). More specifically, these findings suggest that job quality accumulation and timing of work exposure change in later working life may pronounce the effects found previously.

To shed light on the role of job quality and MTW in the work-retirement transition, this study aims to explore whether and how job quality changes in the pre-retirement years, and whether and how changes affect MTW. The latter is done by testing MTW effects of the following hypothesized exposure patterns over time. It was predicted that:

- H1: workers with constant favourable job quality exhibit highest and the adverse counterpart the lowest MTW levels.
- H2: early change from adverse to favourable job quality (= early improvement) is associated with higher MTW levels compared to constant adverse exposure.
- H3: early change from favourable to adverse job quality (= early deterioration) is associated with lower MTW levels compared to constant favourable exposure.
- H4: later change from adverse to favourable job quality (= later improvement) is associated with lower MTW levels compared to early change (= early improvement).
- H5: later change from favourable to adverse job quality (= later deterioration) is associated with higher MTW levels compared to early change (= early deterioration).

### 2.2.2 Method

For this purpose, data from the first three waves (in 2011, N=6.585; in 2014, N=4.244, and in 2018, N=3.586) of the lidA cohort study was used. Participants were included in the present analyses, when being subjected to social insurance contributions and employed for at least 1 h/week at each wave. For the investigation of job quality change over time, valid data was available for N=2.863 after stochastic regression imputation. For hypothesis testing of trajectory effects on MTW, valid data for N=1.582 remained (MTW scores not imputed).

For the measurement of job quality, this study draws upon the typology of five job quality profiles among baby boomers in Germany, previously established with lidA data from 2011 in study I (Hasselhorn, Stiller et al., 2020). The profiles have the advantage of differentiating two predominantly manual profiles (PQ with an adverse and RM with a favourable exposure constellation) and three predominantly non-manual profiles (SnM with an adverse, SR and HF with a favourable exposure constellation, respectively).

Participants were assigned a profile in 2014 and 2018 per highest posterior probability estimated with the equation of the initial latent profile model based on 2011 data (see Hasselhorn, Stiller et al., 2020). Next, the small HF profile was merged with the conceptually similar and large SR profile for appropriate group sizes and to facilitate interpretability (referred to as SR in the following). Job quality trajectories were coded depending on profile assignment per wave. To test the study hypotheses, twelve of all possible 64 trajectories were selected for group comparisons. Constant assignment of

manual workers to adverse job quality in 2011, 2014 and 2018 is depicted by the PQ–PQ–PQ group and by RM–RM–RM for constant favourable exposure. An early change (between 2011 and 2014) from favourable to adverse job quality is depicted by the RM–PQ–PQ and a later change (between 2014 and 2018) from adverse to favourable by the PQ–PQ–RM, respectively. This was done by analogy for non-manuals (SnM, SR).

MTW was measured with the `motivation to work´ scale (Ebener & Stiller, 2019), a five-item self-report instrument, where participants rate the degree to which core aspects of MTW apply such as *`I consider it highly probable that I am going to work until statutory retirement age'* or *`The earlier I can quit working the better'.* A mean score was computed per participant (range 1-5) with higher values representing higher MTW levels.

Profile development over time was explored comparing proportions between waves descriptively and with one-dimensional $\chi^2$-tests. The association between profile assignment and assessment year was tested with a three-way log-linear analysis, and odds ratios (OR) were calculated for profile assignment per wave. Hypothesized trajectory effects on MTW were tested with a Welsh ANOVA and Bonferroni–Holm corrected, planned non-orthogonal contrasts.

### 2.2.3 Results

The proportions of manual profiles (PQ, RM) decreased from 2011 to 2018, while that of non-manual profiles (SnM, SR) increased. This development applied to adverse profiles (PQ, SnM) already between 2011 and 2014, and for all profiles between 2014 and 2018. Thus, older workers shifted to physically less demanding profiles, particularly when adverse job quality preceded.

In the log-linear analysis, high effects were observed for profile continuity between 2011 to 2014, with 42,8% staying in PQ, 55,2% in RM, 41,4% in SnM, and 47,8% in SR, respectively. A similar pattern, although to smaller extend among non-manual profiles, emerged between 2014 to 2018 and 2011 to 2018. Thus, profile continuity prevailed, yet profile changes were apparent for large parts of the sample, especially within manual and non-manual profiles, respectively.

As for individual profile stability, 3,0% of the sample stayed in PQ across all three waves. For RM it was 7,2%, for SnM 3,6%, and for SR 21,3 %. Thus, more than a third (35,1%) of all participants had constant job quality over seven years, while the rest experienced job quality change over time.

In the final analyses, among predominantly manual older workers, significantly higher MTW levels were observed for constant favourable job quality (RM-RM-RM). Changing early from adverse to favourable (PQ-RM-RM) enhanced MTW levels significantly, whereas the reversed exposure pattern (RM-PQ-PQ) had no effect. Also, a later change from adverse to favourable job quality (PQ-PQ-RM) was significantly associated with lower MTW levels. However, no effect was found for such a change from favourable to adverse (RM-RM-PQ). Thus, among predominantly manuals, H1, H2 and H4 were confirmed, whereas H3 and H5 were not.

Among predominantly non-manual older workers, a similar effect pattern emerged with the addition, that an early change from favourable to adverse job quality (SR-SnM-SnM) was significantly associated with lower MTW levels. Thus, H1, H2, H3 and H4 were confirmed, whereas H5 was not. Effect sizes were medium for manual trajectory groups, and small among the non-manual groups.

These findings demonstrate the dynamic development of the work environment in later working life and the importance of job quality accumulation for MTW. They highlight the need to consider explicitly groups of older workers with long periods of adverse work exposure when designing measures to improve job quality, and to focus on a timely implementation among vulnerable groups to assure its intended effects and a higher motivation to work longer in the context of EWL.

### 2.3 Study III

Stiller, M., Ebener, M., & Hasselhorn, H. M. (2023a). Job quality change in later working life and the mediating role of mental and physical health for employment participation. *Journal for Labour Market Research, 57*, 12. https://doi.org/10.1186/s12651-023-00339-6

In Study III, Michael Stiller, Hans Martin Hasselhorn, and Melanie Ebener conceptualized the study. Michael Stiller wrote the manuscript, performed all analyses, and interpreted the data. Hans Martin Hasselhorn contributed to data interpretation and the writing of the manuscript. Michael Stiller, Hans Martin Hasselhorn, and Melanie Ebener have read and approved the final version of the manuscript.

#### 2.3.1 Aim

Study III investigates whether potential health consequences affect non-employment several years later. Recently, and by political aim, employment rates in Germany have increased for older age groups (Naegele & Hess, 2020), while the number of workers reporting health limitations continued to increase (Hasselhorn & Müller, 2021).

To investigate the underlying health mechanisms in the association between job quality and employment participation among baby boomers in Germany, the job quality profiles identified in study I (Hasselhorn, Stiller et al., 2020) were used to assess later-life work exposure. While the causal association of physical (Bernard, 1997; Mayer et al., 2012; Pega et al., 2022) and psychosocial work exposure with health outcomes (Bernard, 1997; Niedhammer et al., 2021; Theorell et al., 2015) has been established well in past decades, the association of health with early exit from employment appears to vary by the respective health indicators chosen (de Breij et al., 2020; van den Berg et al., 2010; van Rijn et al., 2014). In addition, most studies implicitly address health-mediated effects of working conditions through the investigation of ill-health exit routes (e. g. d´Errico et al., 2021; Knardahl et al., 2017; Schram et al., 2020; Söderberg et al., 2014, 2021; van Zon et al., 2022), but do not test for it explicitly.

Thus, the aim of study III was to simultaneously assess continuity and change effects of overall job quality on non-employment in the pre-retirement years, potentially mediated through mental and physical health in parallel (not in separation). Specifically, it was tested whether constant adverse job quality showed a health-mediated risk of non-employment. In addition, as little is known about such change effects, a further aim was to explore health-mediated effects of job quality change in general.

### 2.3.2 Method

Data from the first three waves of the lidA cohort study in 2011 (N=6.585), 2014 (N=4.244), and 2018 (N=3.586) was analyzed. After stochastic regression imputation on the job quality indices (see paragraph below), participants with valid data for all three waves were included in the final sample. In addition, they had to be defined as „employed" in 2011 and 2014 (for definitional criteria see below), which resulted in a final N=2.952.

Job quality was operationalized by means of a typology of five job quality profiles as established by study I (Hasselhorn, Stiller et al., 2020). The small HF profile was merged with the conceptually similar and large SR profile for appropriate group size (referred to as SR in the following). The resulting 16 groups with job quality change between 2011 and 2014 according to profile assignment are summarized in Table 3. Among initially manual groups, for example, PQ-PQ and PQ-SnM represent constant adverse job quality, PQ-RM and PQ-SR represent job quality improvements, RM-RM and RM-SR represent constant favourable job quality, and RM-PQ and RM-SnM job quality deterioration. The latter of each pair also includes a change of type of work. This applies by analogy for initially non-manual groups.

Table 3

*Character of job quality exposure from 2011 to 2014 in study III (as per profile assignment, type of work as represented by profile, and assessment year)*

| | Job quality profile 2014 | | | |
|---|---|---|---|---|
| | Manual | | Non-manual | |
| Job quality profile 2011 | PQ | RM | SnM | SR |
| Manual | | | | |
| PQ | — — | — + | — — | — + |
| RM | + — | + + | + — | + + |
| Non-manual | | | | |
| SnM | — — | — + | — — | — + |
| SR | + — | + + | + — | + + |

*Note.* „— —" denotes constant adverse and „+ +" constant favourable job quality exposure, „— +" denotes improvement and „+ —" deterioration of job quality exposure.

Mental and physical health in 2014 were measured with a German adaptation of the SF-12v2 (Nübling et al., 2006a), where each dimension is represented by a separate component summary across 12 self-report items. Higher scores indicate better health.

Non-Employment (coded=0) as the outcome in 2018 was based on the self-reported indication of participating in a qualification measure, being unemployment/on job search, long-term sick-listed (≥ 6 weeks/medical rehabilitation), other (e. g. homemakers), early retirement, or receiving full disability pension. Employment (coded=1) was based on the indication of full-time- (≥ 35 h/week)/part-time-/ marginal employment, receiving partial disability pension, or participating in a job creation scheme. Covariates for sample description included educational level, cohort, and sex. The latter two were also included in all mediation analyses.

Statistical analyses encompassed a descriptive inspection of the job quality change groups´ prevalence and the associated health levels in each group. The direct association of job quality change from 2011 to 2014 with non-employment in 2018 was assessed with binary logistic regression analyses. The final mediation models tested exposure effects of job quality continuity and change on non-employment with mental and physical health as parallel mediators and were calculated separately for initially manual and non-manual workers, respectively.

### 2.3.3 Results

Regarding job quality continuity, 52,4% experienced favourable continuity (RM-RM, SR-SR, RM-SR, SR-RM), while it was 18,9% for adverse continuity (PQ-PQ, SnM-SnM, PQ-SnM, SnM-PQ). With respect to job quality changes, 14,6% experienced improvement (PQ-RM, PQ-SR, SnM-RM, SnM-SR) and 14,4% deterioration (RM-PQ, RM-SnM, SR-PQ, SR-SnM). Changes from manual to non-manual profiles and vice versa applied to 11,9% and 10,1% of older workers. Significant direct associations of job quality exposure with non-employment were found among groups with the highest frequencies of non-employment in 2018, which applied for continuity of adverse manual job quality (PQ-PQ: 12,3%) or its deterioration (RM-PQ: 10,8%). Changes from adverse non-manual to manual profiles were likewise associated with higher frequencies of non-employment in 2018 (SnM-PQ: 6,3%, SnM-RM: 8,9%), but without statistical significance.

In the final mediation analyses, among initially manual groups, those with constant adverse job quality (PQ-PQ, PQ-SnM) had a significantly increased risk of non-employment mediated through poor mental health compared to constant favourable exposure (RM-RM). This risk was also significantly increased for adverse exposure at one instance (PQ-RM, RM-PQ, RM-SnM). Additionally, adverse continuity (PQ-PQ only) was significantly associated with an increased risk of non-employment mediated through poor physical health. This risk was significantly reduced when favourable job quality continuity included a change to non-manual work (RM-SR). All significant indirect effects were of small size.

Among initially non-manual groups, compared to favourable job quality continuity (SR-SR), data indicated that changing to manual work (SnM-PQ, SnM-RM, SR-PQ, SR-RM) was associated with an increased risk of non-employment mediated through poorer physical health, however without statistical significance.

The findings confirm the risks and benefits of job quality for health and employment participation and underscore the role of both mental and physical health as a pathway in the association of job quality exposure and employment participation several years later – particularly among baby boomers in manual jobs. When aiming at maintaining the employability of older workers in the context of EWL, manual workers with poor quality jobs need to be considered with special attention and interventions require a timely implementation to increase employment participation for vulnerable working groups in good health.

### 2.4 Synopsis of the study results

Below, Figure 1 graphically depicts the five job quality profiles identified and validated in study I. Here, red bars denote adverse manifestations and green bars denote favourable manifestations of the respective characteristics (adapted from Hasselhorn, Stiller et al., 2020). Afterwards, a tabulated overview is presented which summarizes the main results obtained across all three studies included in this thesis, and which are associated with effects of these job quality profiles on health and employment (Table 4).

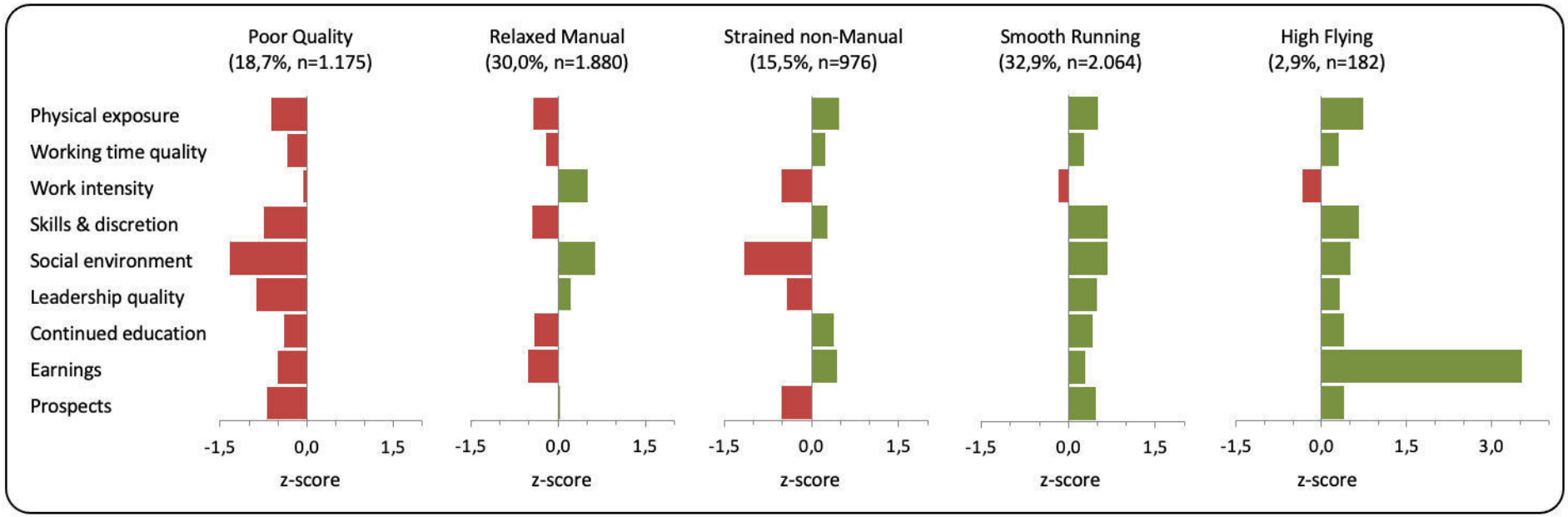



*Figure 1.* Job quality profiles from study I

Table 4

*Main findings from study I to III*

| | Job quality profiles (from study I) | | | | |
|---|---|---|---|---|---|
| | „Poor Quality“ (PQ)[b] | „Relaxed Manual“ (RM)[b] | „Strained non-Manual“ (SnM)[c] | „Smooth Running“ (SR)[a,c] | „High Flying“ (HF)[a, c] |
| **Results from study I** | | | | | |
| Profile demands[+] | high physical exposure<br>poor work time quality<br>low skills & discretion<br>poor social environment<br>poor leadership quality<br>low continued education<br>low earnings<br>poor prospects | high physical exposure<br>poor work time quality<br>low skills & discretion<br>low continued education<br>low earnings | high work intensity<br>poor social environment<br>poor leadership quality<br>poor prospects | high work intensity | high work intensity |
| Profile resources[+] | / | low work intensity<br>good social environment<br>good leadership quality | low physical exposure<br>good work time quality<br>high skills & discretion<br>high continued education<br>high earnings | low physical exposure<br>good work time quality<br>high skills & discretion<br>good social environment<br>good leadership quality<br>high continued education<br>high earnings<br>good prospects | low physical exposure<br>good work time quality<br>high skills & discretion<br>good social environment<br>good leadership quality<br>high continued education<br>extremely high earnings<br>good prospects |
| Educational level | low, medium | low, medium | medium, high | medium, high | medium, high |
| Task requirement level | mostly skilled | mostly skilled | skilled, (highly)complex | skilled, (highly)complex | (highly)complex |
| Predominant work type[+] | manual | manual | non-manual | non-manual | non-manual |
| Mental health | lowest | second highest | lowest | highest | medium |
| Physical health | lowest | second lowest | medium | second highest | highest |
| Work-privacy-conflict | highest | lowest | highest | second lowest | medium |
| Work ability | lowest | medium | second lowest | second highest | highest |

Table 4

*Overview of main findings from study I to III (continued)*

| | Job quality profiles (from study I) | | | | |
|---|---|---|---|---|---|
| | „Poor Quality“ (PQ)[b] | „Relaxed Manual“ (RM)[b] | „Strained non-Manual“ (SnM)[c] | „Smooth Running“ (SR)[a,c] | „High Flying“ (HF)[a, c] |
| **Results from study II:** | | | | | |
| Profile size[+] | constant decrease | lagged decrease | constant increase | lagged increase | |
| Motivation to work (MTW) | profile continuity is associated with low levels, early improvement with higher and lagged improvement with lower levels of MTW | profile continuity is associated with high levels of MTW | profile continuity is associated with low levels, early improvement with higher and lagged improvement with lower levels of MTW | profile continuity is associated with high levels and early job quality deterioration with lower levels of MTW | |
| **Results from study III:** | | | | | |
| Risk of non-employment | increased in case of profile continuity (direct effect) | increased in case of job quality deterioration (to manual; direct effect) | no direct association | no direct association | |
| Mental health | mediates the association of constant adversity or improvement (to manual) and increased risk of non-employment | mediates the association of job quality deterioration and increased risk of non-employment | no significant mediation, constant adversity is associated with lowest and improvement (to non-manual) with low levels of mental health | no significant mediation; job quality deterioration is associated with lowest levels of mental health | |
| Physical health | mediates the association of profile continuity and increased risk of non-employment | mediates the association of improvement (to non-manual work) and decreased risk of non-employment | no significant mediation; change to manual work is associated with lower levels of physical health | no significant mediation; change to manual work is associated with lower levels of physical health | |

*Note.* Statistically significant results reported, unless marked otherwise; [+] descriptive or qualitative results; [a] SR and HF were merged in study II + III; [b] RM-RM=reference group in study III, [c] SR-SR=reference group in study III.

# 3 General discussion

Over the three studies recapitulated above, and for the first time in Germany, it was shown that a valid job quality typology can be established among older employees, indicating groups with differential work exposure and considerable job quality change in later working life. Accumulated exposure to these different work environments and their improvement and deterioration were systematically associated with the motivation to work, with mental and physical health, and, in the long-term, with non-employment.

In the following chapter, a detailed discussion is provided concerning these findings. In particular, the following aspects will be covered subsequently: the conceptualization and operationalization of job quality (3.1) and the different exposure patterns representing later-life job quality as well as its effects on the work-related outcomes (3.2). After that, implications on the meso- and macro level and for future research are addressed (3.3). The limitations and strengths are discussed critically as well (3.4). The thesis closes with a general conclusion and outlook (3.5).

## 3.1 Measuring job quality from the employees´ perspective

As was demonstrated across the thesis, the quality of the job does matter for older employees and differs considerably. The first of the main research questions deals with the operationalization and measurement of job quality in Germany and the identification of groups exposed to adverse and favourable work environments. The application of a person-centred analysis approach and the adoption of the exposure perspective of the working individuals allowed to address directly the multidimensionality of job quality (see 1.3.1), and, above that, the complex interplay among the job quality characteristics included, which may have conceptually advanced the scientific investigation of work environments in later working life.

Methodologically, this approach enabled to determine and describe the optimal number of subgroups of individuals similarly exposed to certain work environments, and also to investigate the relationship of subgroup membership with certain work-related outcomes. Similar research attempts have gained attention in recent occupational epidemiological studies (see e. g. Bouwens et al., 2024; Bujacz et al., 2018, 2021; Eurofound, 2017; Gut et al., 2024; Jonsson et al., 2021; Vanroelen et al., 2010). In most instances, the focus was put on specific job quality domains such as vulnerabilities (Bouwens et al., 2024) or occupational stressors in the full range of working age (Vanroelen et al., 2010), resources among older employees (Gut et al., 2024), psychosocial working conditions among specific working groups (Bujacz et al., 2018, 2021), or low-quality employment (Jonsson et al., 2021). Such research attempts are important to address the heterogeneity of the workforce and the distribution of the respective job quality domains mentioned, but disregard job quality in its entirety. By following the job quality concept of Eurofound (2017), both well-established demands and resources from multiple job quality domains were simultaneously integrated in the analyses of the

present thesis with respect to the German labour market (Hess et al., 2020, p. 106). This enabled to detect typical constellations that a) included mainly presence of resources (SR and HF) or their absence in concurrence with the presence of multiple stressors (PQ), but also b) constellations that included different manifestations of demands and resources alike (RM, SnM; Hasselhorn, Stiller et al., 2020), with considerable consequences for overall job quality and the outcomes associated with each profile as demonstrated across study I to III (Hasselhorn, Stiller et al., 2020; Stiller et al., 2023ab). Thereby, and with respect to the work-related outcomes investigated, maintenance (among SR and HF) and deterioration processes (among PQ and SnM) were illustrated, but also compensation mechanisms for certain stressors in the presence of crucial resources (among RM). Consequently, the results suggest that job quality characteristics that might stand out in one work environment always need to be viewed and interpreted against the backdrop of the remaining characteristics in it (Knardahl et al., 2017, p. 24). This became remarkably evident when contrasting the differences found in MTW and health for PQ versus RM, and also for SnM versus SR. Put more metaphorically, certain prominent work factors may represent the play in some workplaces. The remaining work environment, however, always needs to be regarded as the stage it takes place on.

Together, and for the first time, the findings portray the everyday working situation of older working groups in Germany in a more comprehensive and realistic manner than in previous scientific investigations (see Eibich, 2015) and enabled to draw a more fine-grained picture of this large collective. The findings obtained with the person-centred analysis approach stress the fact that a sheer focus on occupations or jobs may bias the perception of the older workforce concerning work capacity and needs and worries in this working life-stage. This, again, is reflected in the distribution of individuals in PQ with RM, and also in SnM with SR: when considering sociodemographic characteristics and occupations only, PQ and RM, but also SnM and SR might appear as one large group in the older workforce, respectively. Such a perception would be misleading though, as RM and SR can be characterized as clearly more advantaged in contrast to PQ and SnM in terms of typical work exposure and its motivational and health effects (see 3.2; c. f. also Brussig, 2010). As a consequence, a further discussion of each profile should also involve the social distribution of work characteristics associated with exposure to the respective profiles.

### 3.2 Structure of later-life job quality and its effect

To this point, the occupational literature was lacking comprehensive evidence concerning the real-life working situation of baby boomers in Germany, although the socioeconomical impact of their approaching retirement transition urgently concerns policymakers (OECD, 2018b, 2019), political stakeholders (Eurofound, 2025; Nullmeier, 2025), and the scientific community alike (e. g. Frerichs, 2015; Fuchs et al., 2018; Hasselhorn & Apt, 2015; Hofäcker, 2015; Hofäcker & Hess, 2022). Thus, two further questions guided the research activity in this thesis: how does job quality develop in later

working life and does its accumulation and timing affect MTW? And further, how does job quality continuity and change affect health and long-term employment participation? The evidence obtained across study I to III demonstrated that work environments for individuals in predominantly manual (see 3.2.1 and 3.2.2) and non-manual work (see 3.2.3 to 3.2.5 and also Figure 1) can be identified, respectively, that these work environments diverge in size over time, and that they are related in a specific manner to MTW, health, and non-employment. Therefore, the following issues will receive fair consideration in the subsequent discussion of each job quality profile: the description of the profile including vulnerabilities and/or resources associated with it, profile development over time, the role of MTW for the employment perspective, and the role of health for employment participation.

### 3.2.1 The `Poor Quality´ profile

The work environment of nearly one out of five older workers in Germany (18,7%) by the year of 2011 is represented by this job quality profile. As study I showed, the PQ are almost completely exposed to adverse manifestations of the job quality characteristics included, with most manifestations at the lower limit of average range and with `social environment´ falling below average level. Above that, the assigned workers cannot draw upon any job resources (see Figure 1). In addition to higher age as a vulnerability applying to all individuals under study, further vulnerabilities that cumulate in PQ are low-to-medium educational level, predominantly manual work, poor mental and physical health, poor work ability, and the highest work-privacy-conflict (Hasselhorn, Stiller et al., 2020).

Concerning life-course work exposure, study II found an initial and progressing decrease of the PQ profile over seven years by more than one third in size (Stiller et al., 2023b). The large shift to the remaining profiles might be explained by individual overextension through ageing-driven, already reduced work capacity in combination with both a physically strenuous and psychosocially demanding work environment without the possibility to compensate with adequate job resources. This is also reflected by the lowest individual seven-year stability among all profiles with 3,0% (Stiller et al., 2023b).

A considerable part of study II was dedicated to the effects of job quality accumulation on MTW. In this sense, lowest MTW levels were evident in case of constant exposure to PQ. A change of job quality exposure affected MTW levels differently. Here, the timing of changing from PQ to favourable job quality (= improvement) proved to be critical, as an early improvement was associated with higher MTW levels, whereas later improvement was associated with lower MTW levels (Stiller et al., 2023b). Conceptually similar findings were obtained in a study investigating the processes associated with job demands and resources on the one hand and early retirement intentions on the other hand (Schreurs et al., 2011). Against the backdrop of the `Job Demands-Resources´-Model (Demerouti et al., 2001), Schreurs and colleagues found job resources in a sample of about 1.800 Belgians aged 45+ years to be negatively related with early retirement intentions through a motivational enhancement process, and that this relationship was more pronounced among blue collar than white collar workers. Bigger effect

sizes among predominantly manual- compared to non-work environments were obtained in study II as well (Stiller et al., 2023b), thus reflecting the magnitude of these findings. Although Schreurs et al. assessed only a limited number of job demands and resources, the authors assumed that general scarcity of job resources among blue collar jobs may lead to increased sensitivity or stronger responses to resource availability among them (Schreurs et al., 2011, p. 15). Such an explanation might also apply to individuals in PQ concerning their MTW levels after a job quality improvement, however with the restriction that timing of resource availability moderated this association (Stiller et al., 2023b). It also needs to be acknowledged, that the combination of high demands and lack of resources may in general prevent effective coping among the PQ, leading to further accumulation of demands through a health impairment process and, in consequence, further potentiating of motivational and mental health problems (Frins et al. 2016).

The combination of a variety of job demands with absence of job resources in a predominantly manual work environment might pose a serious risk of further mental and physical health damage, and study III showed that both health components mediated the increased risk of non-employment in the long-term (Stiller et al., 2023a). With reference to the mentioned vulnerabilities associated with PQ, a low educational level, manual work, and a poor health status were identified already in the past as risk factors for early exit from employment (e. g. Scharn et al., 2018; Wilson et al., 2020). In particular, an adverse work environment comparable to PQ has already been found elsewhere to increase this risk (d´Errico et al., 2021). The finding of study III, that a job quality improvement did not abolish the mediation effects through poor mental health, underpins the overall adversity of the PQ profile once more (Stiller et al., 2023a). In case of entering unemployment as one form of non-employment, a stronger negative impact on mental health was observed in the German working population compared to temporary employment (Gebel & Voßemer, 2014), so that even feedback loops of poor working- and employment conditions and exit from the workforce might potentiate the negative health consequences for workers in PQ (van de Ven et al., 2022). An incremental health risk – particularly concerning physical health – may emerge through prolonged work exposure in PQ when e. g. delaying retirement for financial reasons. This trend was found to be increasingly prevalent among low-skilled and low-income workers in Germany (Hess et al., 2020). Accordingly, study III mirrored the distinct health risks of workers in PQ as the increased risk of non-employment was mediated in parallel through physical health for adverse continuity in a physically straining work environment (PQ-PQ), but not in case of adverse continuity including a change to non-manual work (PQ-SnM; Stiller et al., 2023a).

In sum, the PQ may represent a highly vulnerable working group and – in light of the combination of individual vulnerabilities as well as manual and adverse work exposure – with the most disadvantaged position on the labour market (c. f. van den Berg et al., 2010). In addition to the poor work-related outcomes and the health-mediated effects on non-employment observed, they may

have difficulties to draw upon other personal resources such as MTW, which might not only affect early exit from the workforce, but also their employment perspective in the long-term. Together, this may indicate workers in PQ as a distinct, disadvantaged working group at the lowest end of the social gradient (Mielck, 2012; Montano, 2022), and consequently, their need for comprehensive health prevention and timely workplace interventions. At the same time, changes in the working situation of PQ indicated also the potential for beneficial motivational and health effects on the outcomes mentioned. Interestingly, individuals assigned to PQ share the same distribution of sociodemographic characteristics with another predominantly manual profile, the RM, meaning the older workforce contains a similar group, however definable by their work environment and its effects.

### 3.2.2 The `Relaxed Manual´ profile

The second predominantly manual job quality profile comprises nearly one third (30,0%) of the older working population by the year of 2011. Those assigned to RM are exposed to adverse manifestations of physical exposure, working time quality, skills and discretion, continued education, and earnings, but in contrast to PQ (see 3.2.1), they can draw upon psychosocial job resources in the form of favourable work intensity, and a better social environment and leadership quality. The levels of all job characteristics are in average range (see Figure 1). Besides low-to-medium educational level and predominantly manual work as individual vulnerabilities next to their age, they exhibit markedly better mental health and slightly better physical health compared to PQ, medium work ability and the lowest work-privacy-conflict among all profiles identified (Hasselhorn, Stiller et al., 2020).

Concerning life-course work exposure of RM, study II found a progressing decrease in profile size over seven years nearly as much as that of PQ, however with a lagged onset. The latter might reflect the presence of specific resources in this work environment which may at least decelerate the adverse health effects of physically straining work. Even though a large shift to other profiles was observed for RM just as was for PQ, their individual seven-year stability was more than twice as high with 7,2% (Stiller et al., 2023b), which further reflects the more advantageous constellation of job quality characteristics in this manual profile.

The favourable character of the RM profile, at least from a psychological point of view, is further underpinned by the results of study II indicating the potential for motivational enhancement as well as for compensation and buffering processes. Constant exposure was associated with highest MTW levels. Availability of job resources as in RM, most likely in case of constant exposure, may enable older workers to accumulate more resources in the future as was found by Frins et al. (2016), thereby affecting positively their employment perspective. In addition, an early change to RM – after exposure to an adverse work environment in the form of PQ – was associated with higher MTW levels (Stiller et al., 2023b). This might point at the compensatory potential of favourable psychosocial work exposure, particularly for previous adversity in a manual work environment (Schreurs et al., 2011). It is important

to note that timing of job quality deterioration, in the form of a change from RM to PQ, did not affect MTW levels systematically over the seven-year study period (Stiller et al., 2023b). This indicates a general sensitivity to loss of job resources among manuals in later working life and may have significant implications for the enhancement of their employment perspective in interventional terms.

The findings from study III underscore the beneficial role that certain manifestations of job quality characteristics play in this work environment for health. Concerning mental health, the direct association with this health component and the risk of non-employment mediated through it in case of job quality improvement (PQ-RM) were smaller in contrast to constant exposure to PQ, which may indicate compensation of psychosocial strain. Concerning physical health, the risk of non-employment was not increased in case of job quality deterioration (RM-PQ), which supports the protective function concerning physical health in this work environment (Stiller et al., 2023a). On the one hand, this might be explained with a stronger response of the RM to selective resource availability as was done by Schreurs et al. (2011). Another explanation may be provided by the `Job Demands-Resources´-Model (Demerouti et al., 2001), where the presence of specific resources may buffer the adverse health effects of physically straining working conditions to a certain extent. Thus, older workers in a predominantly manual work environment as represented by RM appear to be a more resilient group, that may potentially be less prone to additional health damage when extending their working careers (Hess et al., 2020). However, the physical health impact of manual work still needs to be acknowledged as study III found that the risk of non-employment, when mediated through physical health, was significantly reduced when job quality improvement included a shift to a work environment with less physical strain (RM-SR). Conceptually, this is in line with the results by Söderberg et al. (2021), who found a lowered risk for disability benefits among a large cohort of Swedish construction workers aged 60-64 years, when having moved to occupations in other industries at age 55.

To summarize, the RM may represent a group of workers in predominantly manual work but with a more advantageous constellation of job quality characteristics in contrast to PQ. Despite the physical strains in their work environment, these workers can draw upon more job resources mainly in the form of a favourable social work environment and also upon more personal resources such as better mental health and high MTW. This represents a clear advantage for older workers during the pre-retirement years and particularly in times of EWL (Hess et al., 2020). The effects found for RM in study II and III give selective indication of their health prevention needs and starting points for the implementation of targeted workplace measures. In addition, there may be potential for health improvement among these workers through change into work environments characterized by less physical strain. The fact that PQ and RM share individuals with the same sociodemographic characteristics highlights the impact of the work environment and prompts to pay more attention to differences in working conditions rather than focussing solely on jobs or occupations.

### 3.2.3 The `Strained non-Manual´ profile

Among the profiles representing work environments of predominantly non-manual work, the SnM stands out with a constellation that is complementary to that of RM (see 3.2.2) in every respect (see Figure 1). More than every sixth older worker (15,5%) in Germany was exposed to that job quality profile by the year of 2011, which is characterized by adverse manifestations of work intensity, the social environment, leadership quality, and prospects. Instead, physical exposure, working time quality, and skills and discretion are manifested favourably, just as continued education and earnings. Most levels of the job quality characteristics are within average range. However, it is important to note that the manifestation of `social environment´ falls below average level just as in the PQ profile. Individual vulnerabilities that cumulate in SnM according to study I are poor mental health, the highest work-privacy-conflict, and the second lowest work ability. Potential resources are predominantly medium-to-high educational level and non-manual work (Hasselhorn, Stiller et al., 2020).

Concerning life-course work exposure of SnM, study II found an initial and progressing increase in profile size over seven years of nearly 40% (Stiller et al., 2023b). This might reflect the migration found for workers from predominantly manual to non-manual work environments in addition to the higher mobility among the non-manual profiles. The adverse character of SnM is mirrored in the second lowest individual seven-year stability among all job quality profiles with 3,6% (Stiller et al., 2023b), which might be attributable to overall higher fluctuation resulting from the constellation of job demands and resources in SnM.

The adverse character of SnM is further underlined by the findings from study II. These resemble mostly the pattern of accumulation effects already found for PQ, namely that lowest MTW levels were evident in case of constant exposure to SnM, that early job quality improvement was associated with higher MTW levels and that a later improvement was associated with lower MTW levels (Stiller et al., 2023b). Consequently, a motivational enhancement process through availability of job resources may also enhance the employment perspective of individuals in SnM when changing to favourable work environments (c. f. Schreurs et al., 2011). In line with the findings from Schreurs and collegues, the effect sizes found for non-manuals in study II were smaller than among manuals (Stiller et al., 2023b). The absence of social job resources in SnM – as shared with PQ – in combination with the MTW effects found in study II suggests that effective social coping may be prevented among the SnM, which may lead to further accumulation of demands and potential motivational and mental impairments (c. f. Frins et al. 2016). This notion is supported by the additional finding in study II among the non-manuals (in contrast to the effect pattern among the manuals), that an early job quality deterioration was associated with lower MTW levels (Stiller et al., 2023b). Concerning the employment perspective of individuals in SnM, these findings point at the specific indication for early interventions for the enhancement of the employment perspective.

The findings from study III show a direct and negative mental health effect in case of constant exposure to that profile. This effect was smaller but still present in case of job quality improvement (SnM-SR), thus underlining the pivotal adversity of SnM. However, no significant mediation effects were found through both health components (Stiller et al., 2023a). As a consequence, in SnM, the role of mental and physical health in the relationship of work exposure and employment participation may be more complex compared to the manual profiles and may require the consideration of additional – serial instead of parallel – mediators. In this regard, three aspects need to be highlighted for the evaluation of the SnM profile in health terms: first, the inverted exposure pattern of job demands and resources compared to that of RM, second, the similarities in the adverse effects found for exposure to PQ and SnM, which, third, were evident despite the non-manual character of work in SnM. Together, these aspects allow to infer preliminarily, that, despite other job resources available to those in SnM, the combination of high work intensity, especially the lack of social job resources, and poor prospects – as shared with PQ (see 3.2.1) – may distinguish adverse and favourable work environments per se among older employees in Germany.

In sum, the SnM may represent a vulnerable working group with a disadvantaged position on the German labour market. Despite the absence of physical strain, the SnM may lack crucial social job resources, which may be responsible for the adverse mental health and motivational effects associated with that working environment. While prevention and interventional needs of SnM require strong attention, the findings also indicate some degree of specificity concerning future measures. The association with MTW is less pronounced compared to manuals. The role of health for employment participation is currently not as clear-cut and requires further investigation. Interestingly, as with PQ and RM, individuals in SnM share the same distribution of sociodemographic characteristics with another predominantly non-manual profile, the SR, meaning the older workforce contains a similar group definable by their typical work environment and its effects.

### 3.2.4 The `Smooth Running´ profile

This second profile among those of predominantly non-manual work represents the work environment of one third (32,9%) of the older working population by the year of 2011. This group can largely draw upon job resources in almost all respects, as all job quality characteristics are expressed favourably except for work intensity. All job quality manifestations are within total average range (see Figure 1). At the moment, there is no clear indication of specific vulnerabilities for older workers assigned to this profile besides their higher age. Instead, the cumulation of individual resources is striking: predominantly medium-to-high educational level, predominantly non-manual work, second best physical health and best mental health, second highest work ability, and second lowest work-privacy-conflict (Hasselhorn, Stiller et al., 2020).

Concerning life-course work exposure of SR, study II found a progressing increase in profile size over seven years by more than 20%, however with a lagged onset (Stiller et al., 2023b). The latter might reflect the high resource availability in SR, particularly the better prospects compared to the previous profiles discussed, which may support overall stability of that work environment. Besides a somewhat higher association with the SnM, the SR (re)integrates older workers from other profiles to a large extent. This is also reflected in the highest, individual seven-year stability among all profiles with 21,3% (Stiller et al., 2023b), again highlighting the resource-richness of SR. However, these observations need to be interpreted cautiously at the moment as the SR profile was merged with the small HF in study II and III (c. f. Stiller et al., 2023ab).

The findings of study II largely resemble the associations found for RM with respect to MTW differences (see 3.2.2), thus further underpinning the favourable character of SR, as there is indication for potential motivational enhancement through resource accumulation (c. f. Frins et al., 2016) and for compensation but not buffering processes. Constant exposure was associated with highest MTW levels and an early job quality improvement was associated with higher MTW levels (Stiller et al., 2023b), reflecting the compensatory potential of SR for previous adversity. However, as mentioned in 3.2.3, an early job quality deterioration was associated with lower MTW levels, suggesting both the absence of a potential for buffering in SR and a higher sensitivity among non-manuals to loss of job resources with the above-mentioned implications for interventions (Stiller et al., 2023b).

The findings from study III underline the beneficial role of both their good mental and physical health status. In serving as a reference group for favourable work exposure among those initially in non-manual work, all other forms of job quality continuity or change were directly associated with poorer mental health when compared to constant exposure to SR. Only a change to the RM profile (see 3.2.2) showed no significant association (Stiller et al., 2023a). Concerning physical health, a change to both non-manual profiles (SR and SnM; see also 3.2.3) was not associated with poorer physical health, which reflects the absence of physical strain in these work environments. In addition, the resource-richness combined with the non-manual character of work in SR appeared to be beneficial for the physical health among the RM, as this health component mediated the reduced risk of non-employment among them (see 3.2.2; Stiller et al., 2023a). In reference to the findings of a study by Gut et al. (2024), who identified profiles exclusively comprising job resources among European employees aged 50-60 years in 2015, the SR may resemble – to a certain extent – their profile with most psychosocial resources representing rather non-manual workers with higher educational level.

Together, individuals exposed to this work environment may represent a large resilient group clearly with a privileged position on the German labour market, as they are equipped with numerous personal and job resources and good work capacity. In synopsis with the previous profile discussion (see 3.2.1 to 3.2.3), and particularly in accordance with RM, the psychosocial job resources available

in SR appear to be crucial for positive work-related outcomes and, above that, for the employment perspective of workers exposed to them (see Browne et al., 2019). On a large scale, the impact of good physical health may be even more prominent in SR as high physical strain is absent in this work environment. The association pattern with MTW, however, is less pronounced among non-manuals exposed to that work environment. Moreover, just as for SnM, the role of health for employment participation is not as clear-cut as among manuals and requires further investigation.

### 3.2.5 The `High Flying´ profile

This last non-manual profile mostly resembles the job quality constellation of SR (see 3.2.4) and is typical for 2,9% of older employees by the year of 2011. What clearly stands out and characterizes this small profile are the extremely high `earnings´ exceeding three standard deviations. Their work intensity is somewhat more pronounced than in SR (see Figure 1). Therefore, the HF profile probably represents the work environment of a distinct, privileged working group at the upper end of the social gradient (Mielck, 2012; Montano, 2022), which is further underlined by its distribution of sociodemographic characteristics and personal resources: those in HF have primarily medium-to-high educational level, almost exclusively non-manual work, best physical health, and best work ability. Mental health and work-privacy-conflict are medium to second highest. Despite its small size, this profile emerged early and remained stable during the analytical process in study I, thereby indicating significance for the structure of job quality and the characterization of the older working population in Germany (Hasselhorn, Stiller et al., 2020). Nearly every second employee assigned to this work environment is occupied in business organization, accounting, law, and administration. The health care and social sector, and teaching and education are also somewhat prevalent.

The development of HF over time may be described as similar to SR at the moment. However, supplementary analyses with unpublished lidA data showed that the HF profile displays a much steeper increase in size compared to SR, that is, an initial increase between 2011 and 2014 by already more than 37% (own calculations; Schröder et al., 2013; Steinwede et al., 2015), but when looked at across the entire seven-year study period, the increase since 2011 reaches more than 150% by the year of 2018 (own calculations; Schröder et al., 2013; Steinwede et al., 2015, 2018). The data also shows that mainly individuals from SR are entering HF, few do so from SnM and the number from the manual profiles is negligible. At the same time, only very few individuals leave HF after the assessments in 2011 and 2014. Consequently, individual profile stability is assumed to be higher than in SR, and selection processes might potentiate when approaching retirement.

Owed to its small size preventing a detailed analyses and its high similarity in the constellation of job quality characteristics with the large SR profile, the HF was merged with SR for statistical reasons in study II and III, while sensitivity analyses did not indicate biased results in both instances (Stiller et al., 2023ab). As a consequence, the remarks in the above discussion of SR concerning MTW and both

health components may likewise apply to HF (see 3.2.4). It is nonetheless important to note its preliminary character. Separate analyses of this profile may give more insights into this rather exclusive work environment in the future.

Just as in SR, individuals exposed to a work environment as in HF may represent a resilient but more selective and financially very well-situated small group, with a highly privileged position on the German labour market. Their work exposure constellation may be most favourable and personal resources such as good health and work ability support their already high work capacity. While the findings for SR also apply to HF at the moment, future separate analyses are needed to investigate the specific role of MTW and health among the HF for their employment perspective and employment participation in contrast to that of the remaining work environments identified in this thesis.

Overall, the older workforce in Germany was found to be a heterogeneous group concerning typical characteristics of their working situation. More than one third is exposed to poor job quality, referring to the PQ in manual work and the SnM in non-manual work. Nearly another third, predominantly in manual work, is exposed to a combination of job demands and psychosocial job resources (the RM). Favourable job quality was found among more than one third of older workers in predominantly non-manual work, namely the SR and HF. Over the course of time, individuals shifted from manual to non-manual work environments, particularly when adverse job quality preceded. Specific exposure accumulation had systematically effects on the employment perspective of older workers: a timely job quality improvement was found to enhance MTW among manuals and non-manuals alike, whereas early job quality deterioration was associated with decreased MTW among non-manuals only. Mental and physical health were differently affected by continuity and change of job quality exposure. However, these health effects were associated with different risks of non-employment only among certain exposure groups initially in manual work. Together, the findings expose an unequal allocation of vulnerabilities and resources as well as risks and benefits of work among older workers in Germany, with consequent differential needs for prevention and intervention concerning their employment perspective and employment participation.

### 3.3 Theoretical and practical implications

The previous discussion illustrated the structure of job quality identified, characterized the groups assigned to the respective work environments, and the demonstrated the deviating impact of the associated work exposure on the individual level. The following section, first, considers the relevance of these findings for organizations and for interventional utility in particular. Next, on policy level, the implications for employment, inclusive labour force participation, and sustainable implementation of EWL measures will be addressed. On societal level, social inequality concerns will deserve special recognition. Finally, starting points for future research will be outlined.

### 3.3.1 Organizations

The connection between job quality, workforce health and organizational outcomes is well documented and of particular concern in the context of demographic ageing (OECD, 2020, p. 117). The job quality differences and its association pattern with health and employment (as found across study I to III; see 3.2; Hasselhorn, Stiller et al., 2020; Stiller et al., 2023ab), may translate to considerable differences in productivity outcomes such as higher sickness absence or higher presenteeism among certain groups (OECD, 2020). At the same time, they point at differential health safety and health prevention needs among these working groups (c. f. Crawford et al., 2010), as one in three older workers in Germany is exposed to adverse job quality (Hasselhorn, Stiller et al., 2020). Individuals in poor quality and manual work (PQ) comprise 18,7% by the time of 2011 and had the poorest health outcomes. Another 15,5% are found in poor quality but non-manual work (SnM), which was mirrored in poorest mental- but medium physical health (c. f. 3.2.1 and 3.2.3; Hasselhorn, Stiller et al., 2020). Study III showed that nearly every fifth older worker experienced some form of adverse job quality continuity, and roughly another 30% experienced exposure to adversity at one of two assessments (c. f. 2.3.3). Together, these exposure patterns had a systematical, negative impact on health, which increased the risk of non-employment in most instances, however among individuals initially in manual work only[7] (Stiller et al., 2023a). Another 30% of older workers are found in good quality but manual work (RM), which was reflected in good mental- but poorer physical health (c. f. 3.2.2; Hasselhorn, Stiller et al., 2020). And finally, more than every third older worker in Germany is exposed to favourable job quality, with 32,9% (SR) and 2,9% (HF) found in good quality and non-manual work with accordingly better health outcomes (c. f. 3.2.4 and 3.2.5; Hasselhorn, Stiller et al., 2020). Therefore, the potential for differential indication of occupational interventions, for more effective intervention design, and for differential enhancement of the employment perspective will be addressed subsequently.

First, Robroek and colleagues (2021) mention the need for better targeted interventions, a stronger consideration of the work context, and the lack of clear implementation strategies and of understanding intervention effectiveness in real-working-life settings as gaps in the literature on workplace health promotion. In reference to the first gap, Robroek et al. (2021) stress the special need among lower socioeconomic groups for health-improving interventions yet acknowledge the challenge for practitioners and researchers to reach out to them (for Germany see e. g. Gerbing & Mess, 2019). Here, the PQ and RM profile may enable to differentiate among the lower socioeconomic group in the older workforce, thereby allowing to better target interventions concerning health and work-motivational risks among them. The PQ are by far the most disadvantaged group when it comes to mental and physical health impairments, low MTW, and increased risk of non-employment (see 3.2.1),

[7] Representing at least 22,2% of the entire study sample (see Stiller et al., 2023a).

so that organizations may be interested in monitoring and prioritizing them in the protection of employability (c. f. Eßl-Maurer et al., 2022). At the same time, maintenance or improvement of physical health may be assumed as interventional aims among the RM (see 3.2.2), and the differentiation of both working groups may be seen as a clear advancement related to the indication and scope of workplace health promotion. This is further underlined by the fact that work factors account for about one third in socioeconomic health inequalities (Dieker et al., 2019), and it may be important for organizations – and not least their responsibility – to know working groups with such increased risks to timely intervene in the respective workplaces (c. f. Söderbacka et al., 2020). Finally, as already mentioned above (see 3.1), single job quality characteristics such as the demands with adverse manifestations as shared by PQ and SnM might stand out in some instances but need to be viewed and interpreted against the backdrop of the remaining characteristics in a respective work environment (see Figure 1; c. f. also Hasselhorn, Stiller et al., 2020). Here, the profiles identified may enable practitioners and researchers to implement and evaluate the effectiveness of measures more comprehensively. Therefore, the interventional utility associated with the job quality profiles is three-fold as they, first, enable to better target specific (risk) groups with differential interventional indication, second, allow to put a stronger focus in interventions that aim to effectively improve work-environmental characteristics, while third, representing comprehensive real-life work environments against which the effectiveness of implementation strategies can be evaluated.

Next, job quality profiles may allow to better tailor workplace interventions with respect to content, target outcome, and interventional aim. In particular, and against the backdrop of the `Job Demands-Resources´-Model (Demerouti et al., 2001), it was found that the impact of current changes in a work environment concerning job demands may have a stronger impact on individual well-being than changes of job resources, and this, in turn, might have direct implications for planning, implementation, and evaluation of interventions aiming for the improvement of working conditions in general (Brauchli et al., 2013). It is likely that such mechanisms may be more pronounced among older employees, as e. g. timing of job quality deterioration did not moderate the negative effect on MTW levels regardless of the predominant work type, whereas early improvement of job quality did so among non-manuals (study II; Stiller et al., 2023b). Therefore, an operationalization of work environments with job quality profiles including both established job demands and resources may enable practitioners to (re-)design interventions with focus on dominating negative or positive characteristics in a respective work environment, depending on interventional aim or outcome of interest as well as the desired short-term or long-term effectiveness of these measures.

A final implication is related to the subject of a scoping review by Wilson et al. (2020), who aimed to identify contemporary early retirement factors and strategies to encourage and enable longer working lives. The authors found working conditions to be one important contributor in this respect

and suggested occupational health programs, workplace enhancements, and work adjustments as organizational measures to prevent or delay early retirement – however without being able to draw upon sound empirical evidence concerning the success of these strategies at the moment (Wilson et al., 2020). Here, the job quality typology may indicate specific work environments and the associated working groups such as the PQ or SnM when it is aimed to enhance the employment perspective directly or indirectly, as systematical MTW differences among PQ and SnM (study II; Stiller et al., 2023b) or health-mediated risks of non-employment among PQ were attributable to a respective job quality accumulation (study III; Stiller et al., 2023a). The improvement of certain work environments may, however, not only enhance the employment perspective through motivational enhancement or health prevention. It may also allow for a quicker return to work after longer periods of illness, thereby enabling older workers with chronic diseases or other severe health impairments to prolong economic activity (OECD, 2018a, p. 180; Schram et al., 2020). Further, extending working careers may be challenging for organizations also with respect to older individuals who can afford financially for early retirement or who seek to maintain their health status by exiting early from employment (Hasselhorn et al., 2022). These individuals may be less committed to adverse workplaces and, regarding the job quality profiles, a financial affordability of early retirement may generally be assumed for the SR and surely the HF, whereas health maintenance may be aspired by SR, HF, and the RM as well. Therefore, accommodations or improvements of workplaces may also play a crucial role in the enhancement of the employment perspective by this means (e. g. Jonsson et al., 2019; Moen et al., 2016). Measures may include the possibility for promotion-focused job crafting (e. g. Lichtenthaler & Fischbach, 2016; Polat et al., 2017) or flexibilization (e. g. Morelock et al., 2016; Vanajan et al., 2020) and should be offered considerably earlier in working life than has been done to date (c. f. Söderbacka et al., 2020). It needs to be stressed, though, that evidence on the practices and strategies associated with such interventional aims is complex yet scarce, and appears to vary by country, target job quality characteristics, working group and outcome, and the occupational sector investigated (e. g. Berg et al., 2017; Hennekam & Herrbach, 2013; Kooij et al., 2014; Merkel et al., 2019; Wilckens et al., 2021). For example, in a qualitative study in organizations from the health care sector in Germany, Finland and the UK, Merkel et al. (2019) identified multiple organizational measures and management strategies deployed to improve work ability and working life participation. Here, measures were generally of reactive than of proactive character and altogether not age-specific, which may reflect lack of awareness or popularity of age management in this sector in Germany (Merkel et al., 2019). Next, Hennekam and Herrbach (2013) focused on older workers with low occupational status in the graphical, arts, information and media sectors in the Netherlands, their perception of specific human resource practices, and its relationship with early retirement preferences, without finding a significant association. This finding can, however, not be generalized automatically to older workers in Germany

and other sectors and would require validation in a German sample. Further, a representative study by Berg et al. (2017) including socially insured older workers in Germany investigated age-targeted training programs as a strategy to retain older workers. Content specificity or purpose of these programs was not indicated in the data. The authors found older women, especially with lower wages, to be less likely to retire when such programs where offered. Thus, age-specific training may indeed play an important role for the enhancement of the employment perspective, but not for every older worker in Germany alike. It might be worthwhile, though, to reconsider whether single interventions are determinative for general effectiveness and if, instead, bundles of practices may be favoured where several strategies adapted to the respective work environment reinforce each other. In this sense, Kooij et al. (2014) identified four bundles of human resource managing practices for older workers in the construction sector to maintain their current level of functioning. One bundle comprises *accommodative* practices, which help individuals to function adequately at lower levels when maintenance or recovery is no longer possible, such as adjusted work planning, reducing workload, and exemption from shift work or overtime. Concerning the findings in this thesis, such practices may particularly suit individuals in PQ. Another bundle includes *maintenance* practices, which help to maintain current levels of functioning in the face of new challenges, such as ergonomic adjustments, health checks, or safety and health training. These practices may suit the PQ and certainly the RM, and when expanded to other sectors also the SnM to some extent. A next bundle is concerned with *utilization* practices, which intend to help individuals to recover to previous levels of functioning after a loss, such as job redesign, job movement, or task enrichment. Here, workers in RM and SnM may be targeted as full recovery appears to be more likely among them. Finally, the bundle of *development* practices intends to help workers to reach higher levels of functioning, such as career planning or on-the-job-training, which may certainly apply to SR and HF (c. f. Kooij et al., 2014). Overall, work environments in the form of a job quality typology may serve as a means for organizations to target bundles of specific practices to working groups for whom the differential improvement of the employment perspective is aimed for (e. g. with specific tools such as in Wilckens et al., 2021).

In sum, organizations may benefit from job quality profiles as specific groups at risk for negative health and well-being outcomes can be derived. They enable to adapt content specificity in intervention design, thereby potentially raising the effectiveness of such measures in general. In addition, they also allow to differentiate the health prevention and workplace accommodation needs and give starting points for the enhancement of the employment perspective in a systematic manner. For that purpose, labour market policies are required that promote sustainable working- and employment conditions and give practical scope of action to companies in the implementation of EWL policies (Koopmanschap et al., 2013; van der Klink et al., 2016).

### 3.3.2 Policy

In the new OECD jobs strategy, three principles guided the recommendations made for a broad range of public policy areas and comprise, first, the increase of quantity and quality of jobs, second, the demand for labour market inclusiveness, and third, the enhancement of adaptability and resilience of labour markets (OECD, 2018a). So far, German labour market policies neglected the promotion of job quality to large extent and focused on the extension of employment, e. g. by restricting early retirement pathways and by increasing the statutory retirement age (Hofäcker & Hess, 2022; Hofäcker & Naumann, 2015; Naegele & Hess, 2020). Critically, re-employment of older workers has not increased in the meantime (Heywood & Jirjahn, 2016), reflecting the increased risk among older workers to remain in long-term unemployment after exit from the workforce (Bäcker et al., 2017). Instead, a delayed retirement has been encouraged through financial incentivization, thereby disregarding the impact of life-course work exposure and its differential impact on health and work capacity among those who are unable to work longer (Romeu-Gordo & Sarter, 2020). In light of the previous discussion of the job quality profiles in 3.2, quality of work and labour market inclusiveness may be intertwined among certain groups and the probability of exposure to labour market risks and risk of labour market exclusion in higher working age may likely be uneven distributed – to the disadvantage of individuals in work environments such as the PQ and the SnM, and concerning physical exposure solely, also the RM (c. f. Bäcker et al., 2017; Romeu-Gordo & Sarter, 2020, p. 276). Occupational strain across the life-course is hardly recognized in German public pension legislation, although there is a clear association of early retirement entry among individuals exposed to such cumulative adversity compared to those in less straining occupations (Brussig, 2014). When only regarding the PQ in this respect, this might apply to at least 18,7% of older, socially insured workers in Germany by the time of 2011 (Hasselhorn, Stiller et al., 2020). On the contrary, more advantaged working groups in terms of socioeconomic status and physically less straining working conditions (Montano, 2022) may be prepared with more individual resources that enable for productive labour market performance and for coping with upcoming labour market risks (Bäcker et al., 2017). The latter groups might be represented by the SR and HF, and to lesser extent by the RM (Hasselhorn, Stiller et al., 2020). Brockmann and colleagues (2009) put this relationship into perspective by summarizing that for individuals with poor health and lower survival chance `early retirement is a necessity, whereas for healthy pensioners it is an asset. Pension reformers should take health differentials into consideration when cutting back pension programs and increasing retirement age´ (p. 160; c. f. also van Rijn et al., 2014). Therefore, a stronger consideration of job quality and individual work capacity may be advised for policymakers when extending employment participation and working lives among older workers in order to assure fairness and effectiveness of future retirement regulation (Hasselhorn, 2020a). Here, future legal regulations may include the provision of framework conditions that encourage for

investments in better working conditions and the adoption of better management practices as well (Böckerman & Ilmakunnas, 2020, p. 9). In addition, as education and life-long learning are rather less prominent in German policy making, a greater political focus hereupon may help to improve employability of older workers in the short- and long-term (Hess et al., 2020). Not least, working individuals that are factually at the borderline of partial disability, but officially perform full-time employment, and also those already receiving partial disability pension, may profit from a political climate that supports organizations in improving quality of the work environment and continued education, thus allowing to adapt to labour market changes and, consequently, to remain longer in the workforce.

A considerable improvement of working conditions may not be realistically achieved in every sector though. Nonetheless, some workplaces are arduous or hazardous to that extent (see Natali et al., 2016) that even suggestions for a full-pension eligibility linked to such work environmental exposure were made in the past (OECD, 2018b). Besides a careful design, there are several concerns on the practicability and large-scale acceptance of such a potential pension system that may prevent a future implementation (Nullmeier, 2025). Therefore, a more realistic way of addressing the social structure of poor working- and employment conditions in the work-retirement transition (Bäcker et al., 2017) may be seen in the facilitation of job mobility (e. g. Alcover & Topa, 2018; Eurofound, 2016), with the aim to allow older workers to timely change into less straining work environments (c. f. Söderberg et al., 2014, 2021), thereby improving working conditions and maintaining health and work ability (Garthe & Hasselhorn, 2021). Here, it may be the responsibility of labour market policies to ensure job mobility options without additional financial insecurity or other detrimental work-related effects on the individual. This may require a close collaboration with employers on the one hand (Noone et al., 2018, p. 12), but needs to be embedded in definite political regulations as e. g. done in countries with a „flexicurity" policy on the other hand (Barnay, 2016; see also Keller & Seifert, 2004, for a concept for Germany; Viebrock & Clasen, 2009). Together, such strategies may increase opportunities for better-quality work while achieving a certain degree of labour market adaptability.

As was shown, not every older employee in Germany benefits from good work. In sum, the findings across the three studies included in this thesis (Hasselhorn, Stiller et al., 2020; Stiller et al., 2023ab) may be relevant for policymakers aiming for a large-scale increase of employment participation and the extension of working lives by indicating the limits and potentials of the EWL agenda among the heterogenous group of older workers in terms of fairness and effectiveness (Hasselhorn, 2020a). A stronger consideration of the quality of life-course work exposure, particularly in higher working age (Bäcker et al., 2017), may help to differentiate EWL strategies without disadvantaging certain social groups additionally as certain workers are already at increased risk for further health damage and poor well-being, therefore finding themselves unable or overchallenged to respond to new emerging labour

market demands. From an Occupational Safety and Health perspective, additional knowledge on the dynamic impact of working conditions on later-life health and employment may also help to identify adverse workplaces and to anticipate the accumulation of disadvantages to timely support the protection of older workers at risk of additional health damage (c. f. Barnay, 2016). Especially in the field of prevention, the findings may add to the evidence base needed to indicate specificity of workplace accommodations required to maintain and improve safety and health protection at work (Robroek et al., 2021). Here, policy should provide the adequate framework conditions to achieve these ends (see Lunau et al., 2022).

### 3.3.3 Society

The following remarks intend to point to further realms where the quality of work may be associated with or have consequences for, as the working individual and organizations are embedded within the broader context of society (Burdorf et al., 2023; Hasselhorn & Apt, 2015; Virtanen et al., 2018). In recent years, there are growing concerns that poor working- and employment conditions bear the potential to add to the weakening of societal cohesion to considerable extent (see Statement of the German Council for Sustainable Development, 2024), thereby affecting a society´s overall quality of life (Darçın, 2016). This prompts the question on societal costs and consequences associated with poor-quality work, particularly in economic, social, and ethical terms. Each aspect will be discussed in a subsequent paragraph.

Stressful work is associated with increased sickness absence in the German workforce and shows at least a trend to be more pronounced among older employees (Götz et al., 2018). Moreover, the psychosocial work environment is a significant contributor to mental health disorders, and musculoskeletal and cardiovascular diseases, which in turn produce high societal costs in the form of disability pensions, sickness absence, and presenteeism (Dobson et al., 2019). Concerning mental health, the relationship of increased depressive symptom severity with increased absenteeism was verified recently in the German workforce aged 40+ years, with that study also quantifying the impact of sickness absence on national labour costs (Eßl-Maurer et al., 2022). Following from the established link between working conditions, work capacity, and productivity, a stronger focus on job quality is demanded with respect to economic growth (OECD, 2018a). But what are the costs of poor job quality to society? For Germany, the direct and indirect costs of absenteeism, disability, and presenteeism were estimated to add up to 29.2 billion Euros (Bödeker & Friedrichs, 2011) by the time of the first lidA assessment (c. f. Hasselhorn et al., 2014). In accounting for demographic development, the national costs for e. g. absenteeism are projected to further increase until the late 2020s in Germany due to the large cohort of baby boomers starting to retire at that time (Vanella et al., 2022). Moreover, a recent review on 74 scientific papers suggests that these costs might differ across productivity outcomes and working age groups (Viviani et al., 2021): the authors found no difference between

younger and older workers concerning presenteeism, but higher absenteeism among older workers. Viviani and colleagues (2021) explain this finding by age-related illness that mediates the association of diminished physical capabilities and absenteeism among older workers. Even though no age differences were evident for presenteeism, the respective productivity loses were generally found to create the highest costs compared to other outcomes such as absenteeism or short-term disability (Dobson et al., 2019). Thus, promoting and improving job quality might increase productivity in multiple ways (Dieker et al., 2019), be it through effects of better health on shorter absenteeism and short-term disability periods or through enhanced performance at work. The above-mentioned implications for workplace safety and health prevention on organizational level (see 3.3.1) are, therefore, also crucial for the reduction of productivity loses and the associated costs on societal level (Viviani et al., 2021). However, costs in the form of health prevention and workplace interventions need to be equitably distributed between policy and organizations (Koopmanschap et al., 2013), particularly as certain work environments with higher interventional need as the PQ and SnM (see 3.2.1 and 3.2.3) are more prevalent in certain sectors (Hasselhorn, Stiller et al., 2020).

Pointing to the social dimension of the findings obtained in this thesis, the distribution of sociodemographic characteristics across the job quality profiles aligns with an unequal distribution of job demands and resources among older workers in Germany (see Figure 1; Hasselhorn, Stiller et al., 2020), thereby reflecting a social gradient with the PQ at the lower end, RM and SnM in between, and SR and especially HF at the higher end. As the highest prevalence of illness and work disability is found among the most vulnerable workers at the lower end of the social gradient (Dobson et al., 2019), it may be ensured that access to prevention and intervention measures – if not specifically adapted – is provided at least equally across working groups (c. f. Robroek et al., 2021; for Germany c. f. Gerbing & Mess, 2019). In light of a prevailing EWL agenda (Ní Léime et a., 2020), it might be critically reconsidered, if the increases in life-expectancy across past decades co-occur with better working conditions and increases in work capacity among all working (age) groups equally. International and national data point to social inequalities in health and mortality risks, with effects of poor working- and living conditions cumulating over the life-course (Bäcker, 2016; Bäcker et al., 2017) and exerting its impact increasingly in higher age (e. g. Bödeker et al., 2008; Choi et al., 2024; Havermans et al., 2018). Therefore, the concept of `working-life-expectancy´ is used in recent occupational health studies to depict the disproportional number of expected years in paid employment due to e. g. more frequent states of unemployment or disability, but also educational inequalities in health and working- and employment conditions among lower socioeconomic groups (e. g. Robroek et al., 2020; Tetzlaff et al., 2022). This way, existing differences in health and longevity resulting from diverging working-life exposure patterns and the herewith associated, accumulated (dis)advantages are reflected more adequately. As a consequence, a lower working-life expectancy may translate to a disproportional

burden concerning work capacity and quality of life among disadvantaged groups such as the PQ when EWL is demanded and the pensionable age is further raised (c. f. de Tavernier, 2020). It might also be debated critically then, to what extent the essential protective function of a pensionable age limit comes to effect among those groups (Künemund & Vogel, 2018, p. 80).

Finally, and in reference to the ethical aspect of job quality, it may be pleaded for a more differentiated view on working-life achievement and the contribution to society particularly of older workers in low-paid and arduous or hazardous jobs. To date, the disproportionate risks and burdens associated with certain occupations or industries are reflected in risk-related early retirement schemes in some European countries to compensate for a shorter life-expectancy (Zaidi & Whitehouse, 2009). Such compensations may be questioned in some instances nowadays, as they are historically rooted in former risk professions with different occupational risks in contrast to the present age. In other instances, the occupational risks surely continue to exist (see Brussig et al., 2011). The findings in this thesis concerning the work environment of older workers in Germany suggest, however, that a sheer focus on profession and job description may require critical reconsideration. This notion is reflected by the profile assignment to PQ or RM among manuals, and to SnM and SR among non-manuals, where the same group of older workers in sociodemographic and occupational terms were allocated to either an adverse or a favourable work environment with the respective individual effects (c. f. Hasselhorn, Stiller et al., 2020). Therefore, in times of EWL and the debate on a further increase of the pensionable age, the disproportional burden associated with working life-long exposure among certain groups – and at a higher level, the working life-time achievement and contribution to society by individuals in these jobs – might be better acknowledged and respected on the basis of the factual work-environmental exposure than on job description and the sheer amount of years worked. The role of the work environment of system-relevant sectors and jobs became dramatically evident e. g. during the COVID-19 pandemic, however, to the cost of poorer health, poorer well-being, and higher stress among older workers (in Germany e. g. Garthe & du Prel, 2025), just as a widening of existing socioeconomic inequalities in health and working- and employment conditions (across European countries e. g. Peters et al., 2022). Such an accumulation of shortcomings in multiple areas of life might impede participation in work and non-work-related activities and promote the risk of societal exclusion in higher age (Naegele & Hess, 2020).

### 3.3.4 Future research

Owed to its contribution to general well-being across the globe, Green and colleagues (2024) demand a higher priority and focus to be given to both job quality and its comprehensive assessment in socioeconomic and labour force surveys. In addition, it is argued in favour of an objective multidimensional operationalization of job quality (Green et al., 2024), which was also accomplished in the present thesis. In general, an earlier onset of monitoring job quality coupled with a higher

periodicity may allow for a timely and detailed detection of life-course work exposure and its development over time. From an Occupational Health perspective, further knowledge on critical periods for prevention and intervention is essential. This way, the respective strategies and measures can be designed better or adjusted to unfold the intended effects in the workforce. Longitudinal data collection with more frequent and earlier assessments may allow scientists to investigate, if negative and positive aspects of work spill over to other life domains and how working individuals respond to it. A better comprehension of the processes and mechanisms associated with it would improve the understanding of the link between quality of work and health (Burgard & Lin, 2013).

Next, a simple differentiation of blue- and white-collar workers may lead to inconclusive or biased results when investigating job quality particularly in higher working age. As was demonstrated in this thesis, older workers in predominantly manual and non-manual work, respectively, may either be exposed to an adverse or a favourable work environment in each instance (Hasselhorn, Stiller et al., 2020) and that this differentiation obtained with the methodological approach used leads to diverging effect patterns in terms of work-motivational and health outcomes, and not least employment participation among older workers (Hasselhorn, Stiller et al., 2020; Stiller et al., 2023ab). It might be informative, therefore, to address predominant work type through such an operationalization in future research. Moreover, the simultaneous integration of both established job stressors and resources in the analyses – however extended with characteristics to be recognized for the German labour market and the target working group such as continued education (see Hess et al., 2020) and leadership quality – may be ascribed more importance in job quality research. Depending on the respective research aim, the focus is sometimes given to e. g. job quality profiles comprising job resources only (e. g. Gut et al., 2024). This, however, bears the shortcoming of obtaining inconclusive or less specific results, as in the study of Gut et al. (2024) on psychosocial working conditions, their `low resource´-profile appeared to comprise workers that in the present thesis were allocated to distinct work environments in the form of PQ and SnM (see Figure 1 and Hasselhorn, Stiller et al., 2020).

Also, the investigation of adverse job quality continuity should be further addressed in future research questions concerning the potential for job quality improvement and its impact on mental and physical health. As became evident in study III, there may be different associations with health or diverging health-mediations with non-employment when adverse continuity included a change between manual and non-manual work, respectively (SnM-PQ and PQ-SnM; see Stiller et al., 2023a). Here, again, longer assessment periods and higher periodicity, not least larger study samples, would allow to elaborate and investigate job quality trajectories in higher working age in more depth. In addition, the rather small Nagelkerke $R^2$ in study III (see Stiller et al., 2023a) may point to the necessity to consider additional predictors such as e. g. living conditions (Choi et al., 2024) and/or more specific health outcomes (Hasselhorn et al., 2022). The latter may also be important concerning the availability

of other personal resources in this working life-stage. At the same time, researchers may pay attention to the favourable work environments identified and verify the potential for EWL among the SR and HF, e. g. by focusing on health and well-being outcomes immediately before, during, and after retirement. In addition, to complement the work exposure effects obtained across all three studies, the investigation of productivity outcomes as mentioned in 3.3.3 may help to further understand to consequences of certain work environments for employment participation. The RM requires further clarification concerning the risks and potentials associated with it, since the combination of (psychosocial) resources coupled with physically straining work stands out among all profiles, but the effects detected so far are not as clear-cut as among the remaining profiles.

Finally, the investigation of within-person variation of job quality effects may be helpful to comprehend better its individual impact and change over time rather than only observing between-person variation (see Truxillo et al., 2015). This may be especially informative in the years approaching retirement and give further suggestions for interventional potential when focusing on effectiveness in the context of EWL.

### 3.4 Strengths and limitations

This thesis includes some strengths that deserve to be mentioned and that go beyond the above discussion, or the topics already addressed in the respective studies published previously (see appendix). First, a clear strength can be seen in the conceptual consideration of a sufficient number of characteristics from multiple job quality domains to fully address its multidimensional character (see 1.3.1). This was previously done by Eurofound (2012, 2017) based on their job quality framework, and in adapting their approach, the inclusion of plenty established job demands and resources enabled for the identification of typical and informative higher-age work environments. Furthermore, specifying additional characteristics that play an important role for the characterization of job quality on the German labour market (e. g. continued education/training; see Hess et al., 2020) and for the working life-stage of the individuals under study (in the form of the `leadership quality´ indicator) together yielded relatively comprehensive profiles which demonstrated validity and plausible effects across all studies (Hasselhorn, Stiller et al., 2020; Stiller et al., 2023ab). This way, the very first qualitative and quantitative depiction of the overall working situation of older workers in Germany could be achieved.

Another strength lies in the representativeness of the data for workers subjected to social security contributions of similar age, the large sample size and age-homogeneity of the sample (Hasselhorn et al., 2014). It is a central aim of the lidA cohort study to investigate effects of work and the work context on physical and mental health and employment participation in higher working age, and as such, it is unique among occupational studies in Germany (for a detailed cohort profile including the two-stage sampling process see Hasselhorn et al., 2014). Due to its research focus, and against the backdrop of a conceptual framework developed exclusively for the investigation of the work-retirement transition

within the lidA cohort study, established measures for working conditions (e. g. ERI; Siegrist et al., 2004; COPSOQ (II); Nübling et al., 2006b; Pejtersen et al., 2010), work and health outcomes (e. g. SF-12vs; Nübling et al., 2006b; WAI; Tuomi et al., 1998), and occupational status and classification variables (e. g. Paulus & Matthes, 2013) are assessed in each wave (c. f. Schröder et al., 2013; Steinwede et al., 2015, 2018). Above that, the prospective cohort study design enables for the analysis of longitudinal data, which, together, makes the data set particularly suitable for the identification of typical work environments and its investigation over the course of time.

Finally, a potential strength refers to the sensitivity analyses conducted in study II and III. In the first instance, MTW scores were checked for potential cohort differences and bias attributable to trajectory selection, albeit without statistical indication of both concerns (Stiller et al., 2023b). In the second instance, it was checked for potential sample selection due to attrition between assessment waves and for potential health bias in case of attrition. With statistical significance, slightly higher attrition could be detected in both manual profiles until 2014, although without affecting baseline health levels. Instead of applying sample weighting to account for the rather small difference in attrition between manuals und non-manuals profiles, priority was given to obtain conservative results. In study III, it was also statistically controlled for covariation by sex and cohort, although it may have been informative to investigate cohort differences additionally. However, this may have prevented the analysis of certain exposure groups already of small cell size in the final analyses (Stiller et al., 2023a).

Several limitations of the present thesis can also be noted in addition to those mentioned in the above discussion, and which also go beyond the in-depth discussion in the respective studies published previously (see appendix). First, the entire study period in all three papers spanned a total of seven years, which can be considered a rather moderate timeframe when aiming to investigate later life-course work exposure. Concurrently, the time lag of three and four years between each assessment can be considered rather large so that a detailed trend analysis of working-life exposure was not possible (c. f. Schröder et al., 2013; Steinwede et al., 2015, 2018). Considering study III (Stiller et al., 2023a), a higher frequency of assessments with shorter timeframes in-between would have allowed to investigate effects of job quality trajectories just as in study II (c. f. Stiller et al., 2023b), which may have revealed more detailed and informative results. In addition, the direct and indirect health effects may have been differently pronounced and a time-wise overlap in the assessment of work exposure and both health components in the 2014 assessment could have been omitted (c. f. Stiller et al., 2023a). By now, a re-analysis of the lidA data including the fourth assessment wave from 2022/2023 (c. f. Ruiz Marcos et al., 2023) would allow to at least account for the latter.

A next limitation can be seen in the static investigation of profile development across the three assessments in study II (Stiller et al., 2023b). Here, statistically more advanced modelling techniques such as `Latent Transition Analysis´ could have been applied to track profile membership with

transition probabilities and to test for the statistical significance of profile change over time (Nylund-Gibson et al., 2023). In general, not less than two statistical programmes were utilized in all three studies, so that more advanced statistical procedures or methods could not be applied, as e. g. `Multiple Imputation´ in study I (c. f. Hasselhorn, Stiller et al., 2020) or `causal mediation analysis´ in study III (c. f. Stiller et al., 2023a). Above that, it was deemed important to investigate specific – thus selected – job quality trajectories that allow for plausible post-hoc comparisons and interpretation of MTW differences in study II.

A final limitation worth to be addressed is the merging of the small HF profile with the large SR profile in study II and III. This was primarily owed to otherwise very small cell sizes of the HF that would have prevented statistical investigation except for descriptive inspection. In light of the already complex subject matter and the many job quality groups coded and investigated in both studies, a higher priority was given to maximize comprehensibility of the findings (see Stiller et al., 2023ab). However, as mentioned in the respective profile discussion (see 3.2.5), there is indication in the lidA data that the HF profile increases distinctly stronger in size than the SR, and it is likely that this small profile will gain more in relevance the closer individuals get to statutory retirement age. More generally, and concerning the remaining profiles, the relatively small cell sizes of certain selected job quality trajectories in study II or specific change groups between manual and non-manual profiles (and vice versa) in study III may have reduced the overall statistical power of the analyses so that particularly in study III, a consistent physical health-mediation among the non-manuals missed statistical significance of these substantially plausible effects (see Stiller et al., 2023a).

### 3.5 Conclusion and outlook

This thesis examined the working situation of baby boomers in Germany by identifying the structure of their job quality in study I (Hasselhorn, Stiller et al., 2020). The conceptual and analytical approach followed here appeared innovative to the extent that a person-centred perspective on work exposure helped to depict the individual evaluation of the everyday working situation of older employees, but also work exposure in later working-life in general. Using representative data from the lidA cohort study allowed to characterize five groups in the working population with respect to typical work exposure in the last working years – spanning the spectrum of good-to-poor quality work. In 2011, favourable job quality was found among more than one third of older workers in Germany, predominantly in non-manual work. The two respective subgroups can draw mostly upon job resources, which appear to have a protective function in the context of later-life employment. Nearly another third, predominantly in manual work, is exposed to a combination of job demands and psychosocial job resources, with findings highlighting this work environment as potentially favourable in psychological terms albeit associated with substantial health risks through physical strain. However, more than one third of baby boomers is exposed to poor job quality. Employees in one of the two

subgroups, predominantly in manual work, are almost completely exposed to adverse physical and psychosocial job demands while lacking any job resources. The other subgroup, predominantly in non-manual work, is lacking exposure to physically straining work but shares other demands with the former group that the potential job resources available to them cannot compensate for. Together, both groups are at serious risk for poor health and work-related outcomes in the last working years and require special recognition in many respects.

Study II investigated job quality development over the course of seven years in later working life and related its accumulation to differences in MTW (Stiller et al., 2023b). In the first instance, the shift from physically straining to less straining work environments reflected the ageing-related decrements in physical health and work ability, and consequently, a global trend to seek working conditions that better fit to the individual work capacity. In the second instance, while the initial, overall character of the respective job quality profiles was mirrored in their accumulation effects on MTW as expected, timing and direction of job quality change showed systematical associations with this motivation and mostly in the expected direction. Resource loss appeared to be associated with negative consequences for older worker per se, however with non-manuals exhibiting a higher sensitivity to it. On the contrary, manuals apparently react with higher sensitivity to resource availability. In times of EWL, both findings may be important in interventional terms and concerning the employment perspective.

Study III found continuity of favourable job quality over two assessments across three years among more than half of the sample, and continuity of adverse job quality among nearly every fifth individual. Improvement and deterioration of job quality were experienced by nearly 15%, respectively. These work exposure patterns varied directly and systematically with poor mental health and exerted long-term mediation effects on the risk of non-employment, albeit only among predominantly manual workers with at least one occasion of adversity exposure (Stiller et al., 2023a). Adverse continuity among manuals was mediated through poor physical health as well, thereby underscoring the vulnerability and risk of early health-related exit from employment among them and also their particular prevention and intervention needs. On the contrary, manuals with favourable exposure changing into non-manual work environments experienced a reduced risk of non-employment mediated through better physical health, thereby suggesting potential for health maintenance among them. Together, when also concerning the findings among non-manuals, temporary and constant adverse job quality affected predominantly mental health, while manual work was found to affect physical health.

Organizations may be supported by the findings in the understanding and managing of the different health safety and prevention needs, and also the employment perspective of their older employees. As per their responsibility for the protection and maintenance of employee health and employability, a stronger focus on the risks and potentials associated with the entirety of working

conditions may enable them to deduce differential indication and to increase effectiveness of interventions, so that workers, who can afford to, may consider remaining longer in employment. Management practices should in general be more adapted and concentrated to the respective working situation. A safe, healthy, and supportive work environment may be aspired for every older worker, yet in some instances, more priority may lie on mental and physical health, whereas in other instances, a supportive social climate may be strongly focused. Here, it may help to increase the assessment frequency of working conditions and feedback from older working groups, so that individual perceptions and needs can be directly discussed and addressed in the promotion of health, well-being, and a productive work environment. This, however, requires close cooperation by policy through flanking legal framework conditions.

As became clear in the discussion of the structure of job quality in later working life, policymakers are demanded to acknowledge and expand the consideration of job quality differences. Higher priority and greater focus in EWL policies and retirement regulations may be given to job quality and potential social inequalities associated with differential work exposure. The findings clearly show that not every individual in higher working age can afford for the extension of their working career without approving negative physical and/or mental health consequences, not least a lower motivation to work. Policy needs to address the different health paths to early retirement (Hasselhorn et al., 2022) and consider the role of the work environment in this context more seriously to ensure fairness of EWL reforms. To achieve a more inclusive labour market, strategies to increase the opportunities for better-quality employment should differentiate between the risks in adverse work environments and potential benefits in favourable work environments. In the first instance, the focus may lie on protection from further physical and mental health damage, possibly by timely interruption of physical and psychosocial strain, while in the second instance, more attention may be given to maintaining physical health, possibly through considerable deceleration of ageing-related decline, and through the enhancement of mental health.

The evidence obtained in this thesis is also relevant to the scientific community, as it is the first quantification and characterization of the entire work environment of baby boomers approaching the pre-retirement years in Germany, thereby highlighting workplaces with overall adverse and favourable exposure and the associated risks and benefits. The identification of these groups may uncover individuals for whom either relief and protection may be of utmost importance to interrupt or decelerate health decline, but also individuals for whom more years in work might be feasible without additional disadvantages under certain conditions. Scientists may be interested in investigating the prerequisites necessary for successful adaptation to EWL among these different groups and the reasons associated with job quality change across later working life. Moreover, earlier and longer monitoring periods and a higher frequency of job quality assessments are needed to understand the

mentioned relationships. In addition, more research is needed to examine deviating mechanisms that may lead to non-employment of older workers particularly in non-manual jobs.

In conclusion, this thesis demonstrated that quality of work among baby boomers varies considerably and that its benefits for health and well-being depend on it, even more so in case of physically strenuous work. Recognizing differences in work exposure may help organizations to understand better the needs and worries of their employees, while policymakers need to acknowledge differences in work exposure and in the ability for labour market performance in higher working age, even more so in times of EWL. For Occupational Science and Occupational Health and Safety, the findings contribute to the understanding of the complex interplay of working conditions and may advance the improvement of workplaces and health protection in the transition from work to retirement.

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# Appendix

## Manuscripts

### Study I

Hasselhorn*, H. M., Stiller*, M., du Prel, J.-B., & Ebener, M. (2020). Work profiles of older employees in Germany – results from the lidA cohort study. *BMC Public Health, 20*, 1452. https://doi.org/10.1186/s12889-020-09542-3

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RESEARCH ARTICLE Open Access

# Work profiles of older employees in Germany-results from the lidA-cohort study

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## Abstract

**Background:** This study investigates whether a typology of work exposure can be established among older workers in Germany. Work exposure comprises physical work, working time quality, work intensity, skills & discretion, social environment, leadership, continued education, earnings and work prospects.

**Methods:** Latent profile analysis was conducted on a representative sample of the socially insured workforce in Germany born in 1959 or 1965 ($N = 6277$). Seven year-prospective associations between the typology and work-related outcomes (physical and mental health, work ability and work-privacy-conflict) were investigated to establish the distinctness of the profiles.

**Results:** Five profiles were identified: "Poor Quality" (19%), "Relaxed Manuals" (30%), "Strained non-Manuals" (16%), "Smooth Running" (33%) and "High Flying" (3%). These profiles exhibited diverging patterns of association with the selected outcomes, thus representing qualitatively distinct subgroups of older workers in Germany.

**Conclusions:** We conclude that a typological approach may broaden the understanding of the ageing work force and the complex interplay of the overall work situation with outcomes of high individual and social relevance such as health, work ability and employment. The five work profiles identified in this study may constitute crucial clusters needed to reliably mirror today's over-all work exposure patterns in the older work force in Germany. They may allow for the comprehensible monitoring of quality of work and personal life among the older work force during their last working years and their transition to retirement in current times of extending working lives.

**Keywords:** Latent profile analysis, Older worker, Work exposure, Working conditions, Health, Work ability

## Background

In 2008, 28% of the working population in Germany were aged 50 years or more, ten years later, the proportion has increased to 40% [1]. This trend has not reached its climax yet, as German policy is concerned to keep older workers as long as possible in the labour market [2]. To evaluate the risks and potentials of extended working lives in the older work force, it is of relevance to know and understand this heterogeneous group in its over-all working situation. The aim of this exploratory study is to identify an empirically derived typology of older workers in Germany according to work exposure.

A common theoretical assumption is that during working life, occupational work factors are exerting a chronic impact on the individual workers' resources such as health [3], attitudes and behaviour [4]. Classical social and occupational epidemiology usually considers single or a combination of specific occupational work factors when investigating occupational risks. Basic research questions resulting from such an analysis approach are, for example, the investigation of the impact of work-organisational factors on work ability [5] and of work stress [6], shift work or extended working hours [7] on health. Research based on the view that a specific

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work factor – measured by a variable – has an impact on a worker's work ability or health follows a *variable-centred approach* [8–15]. However, this view does not take into account the relation and combined impact of the wealth of simultaneous occupational work factors in real working life.

Theoretically, any combination of work factors can be found in the work force. Yet, certain typical constellations may preponderate in a work force, thereby characterising groups of distinct occupational exposure. In recent years, occupational epidemiology has increasingly applied this holistic view by employing a so-called *person-centred approach* in analysis [8–15]. Here, not a specific occupational exposure, but the workers in their characteristic and holistic occupational situation are in the focus of interest [15].

Both, the variable- and the person-centred approaches have their strengths and indications for addressing specific research questions. However, only the person-centred approach allows an assessment of the over-all occupational exposure and thus, the description of typical exposure constellations and their respective prevalence in the working population. Which typical combinations of work factors exist in a population? How many workers in a population are working under "good" working conditions? How many are exposed to "poor work"? This type of knowledge is a precondition for portraying the work force in a population with respect to their everyday work situation. It also allows for the observation of typical work groups over time, for example the older work force during their life-course transition from work to retirement.

### Recent attempts in clustering the work force

Over the past decade, in studies employing person-centred approaches, finite mixture modelling has become increasingly popular in occupational epidemiology [e.g. [8–15]. Some of the studies focussed on selected work aspects, such as employment quality [10–12] or psychosocial working conditions [8] including resources [9]. Three studies targeted a broader range of work exposures, namely physical, psychosocial and work organisational factors. Lowe [15] has by means of latent class analysis (LCA) identified six job quality clusters among a representative sample of about 2000 employed workers in Canada, based on 15 job quality items (see Table 1). In a similar approach, Vanroelen et al. [13] identified five profiles among about 10,000 employees in the Flemish part of Belgium. Finally, the EU-agency „Eurofound" (European Foundation for the Improvement of the Working and Living Conditions) has identified five distinct groups of workers with characteristic work profiles using data from the 2015 round of the European Working Conditions Survey [14]. This survey covers roughly 27,000 workers from 28 European countries (cf. Table 1). In contrast to the earlier studies, Eurofound has used metric work quality indices for identifying distinct classes by applying latent profile analysis (LPA).

The overview of the three work quality typologies in Table 1 indicates that solutions with five to six profiles may be expected when clustering the work force. In each study, a least favourable profile can be identified scoring worst on almost all work indices included in the analyses, typically a manual work profile. In contrast, the identification of a most favourable (typically non-manual) profile is not as clear-cut: a *low stress* profile presented by Vanroelen et al. [13] ranks first for many, but not all work indices. In the Eurofound [14] analysis it remains open whether work exposure of the *high flying* or the *smooth running* is to be preferred. Overall, the results of all studies underline the multidimensionality of work itself and at the same time a certain homogeneity of the working population on a higher level with respect to work exposure.

### Purpose of the present study

So far, no specific work profiles of the German working population have been published. From a national perspective, a shortcoming of the Eurofound profiles is that they reflect the work exposure of the combined work force of 28 European countries. However, there are substantial differences of profile distributions between countries [cf. 14, also 11], indicating that different profiles may emerge when only single countries are investigated. Furthermore, the Eurofound analyses comprise the work population covering the full range of working age [14]. However, for certain scientific and socio-political issues it may be advantageous to focus on specific age groups. For example, when the interest lies in the understanding of the work force transiting from work to retirement, the aim should be to capture the specific work situation of the older work force, which is a function of decades of work-related transitions, experiences, trajectories and contexts [3]. Finally, the cross-sectional data of the European Working Conditions Survey do not allow for longitudinal observations and therefore inferences on outcomes over time.

Therefore, the main aim of this contribution is to identify characteristic work exposure profiles in the older socially insured working population in Germany by means of a person-centred analysis approach [16]. The identified profiles will be described with respect to socio-demographic characteristics of the workers assigned to each of them. Finally, it will be investigated, how the groups differ cross-sectionally and develop over seven years with respect to work-related outcomes.

**Table 1** Overview of work profiles in LCA studies assessing the broad range of work exposures

| Profile (% in sample) | Profile description |
|---|---|
| Lowe [15], 6 profile solution, 2002 workers in Canada | |
| 1. "total rewards" (6%) | non-manual work, most positive scorings for all work indicators assessed, except pay and benefits (ranking 2nd) |
| 2. "decide and say" (9%) | manual work, good scorings for skills and discretion, but poor on pay and work life balance |
| 3. "relationships and balance" (20%) | mixed physical/non-physical work group, good scorings for social work environment indicators, but poor on discretion |
| 4. "economics and support" (12%) | non manual work, positive scorings for all work indicators except discretion, best scorings for pay and benefits |
| 5. "security" (16%) | mostly manual work, good benefits, rather healthy, safe and secure work place, otherwise low scorings, including poor social work environment |
| 6. "few rewards" (37%) | all manual work, most negative scorings for all work indicators assessed |
| Vanroelen [13], 5 profile solution, 10,074 workers in the Flemish part of Belgium | |
| 1. "low stress" (26%) | predominantly non-manual work, low demands, high control, good social relations, high job security |
| 2. "passive manual" (24%) | manual work, average demands, low control, average level social relations |
| 3. "human contacts" (21%) | moderate physical demands and comparably adverse exposure for social work environment indicators |
| 4. "high demand" (18%) | non-manual work, high work demands, high control and an advantageous social work environment, high job security |
| 5. "high stress" (11%) | very high quantitative and physical work demands, adverse social environment, atypical work schedules, high job insecurity |
| Eurofound [14], 5 profile solution, 26,648 workers from 28 European countries | |
| 1. "high flying" (21%) | non-manual profile, high on skills and discretion, good social environment, good earnings and prospect, higher than average work intensity |
| 2. "smooth running" (25%) | non-manual profile, very good social environment and working time quality, very low work intensity. However, low on skills and discretion and especially earnings |
| 3. "active manual" (21%) | distinctly manual profile with good social environment and prospects, otherwise poor working time quality and work intensity |
| 4. "under pressure" (13%) | a mixed, manual non-manual profile characterised by least favourable scores for the social work environment and work intensity. Else higher skills and discretion scores and better earnings, but poor working time quality |
| 5. "poor quality" (20%) | mostly manual profile with less favourable scorings for all indices. Distinctly low skills and discretion, prospects and earnings. |

## Methods

To investigate this, a LPA was conducted on cross-sectional data (wave 1) and the identified profiles were related to four outcomes based on measurements from three waves (1 to 3), thereby constituting a hybrid cross-sectional and longitudinal analysis.

### Study design, sample selection and description

Data of the German lidA Cohort Study on Work, Age, Health and Work Participation was used (www.lida-studie.de). lidA is representative for employed people subject to social security contributions (no self-employed or sworn civil servants), born in either 1959 or 1965 and thus for marking cohorts of the German "baby boomer" generation. Participants were interviewed at home with respect to their work, health, personal life and employment participation, by means of computer-assisted personal interviews. So far, interviews have been conducted at three time points: in 2011 (wave 1) 6585 people participated, in 2014 (wave 2) 4244 and in 2018 (wave 3) 3586. The response rate at wave 1 was 27.3% (RR5 according to AAPOR [17], counting complete cases only) and the cooperation rate was 32.6% (COOP3 according to AAPOR [17], excluding those unable to do an interview from the base) which is similar to that of other German surveys of comparable study design [e.g. [18, 19]. In all instances, the samples are representative for the socially insured working population of the respective age cohort in 2009, when the sample was randomly drawn [20–22]. A detailed description of the lidA Cohort Study and its design is found elsewhere [23].

The sample for the LPA comprised of 6277 participants of the first wave of the lidA study, all being employed workers for at least one hour per week. The number of workers born in 1959 was 2752 (43.8%) and those born in 1965 3525 (56.2%). This uneven age distribution reflects deliberate oversampling of the younger cohort to compensate for future loss due to attrition [23]. Two thousand four hundred ninety-seven participants were male (46.9%) and 3330 were female (53.1%).

To be able to follow up profile-related differences of the outcomes over time, participants with valid data for all three waves were selected ($n = 3118$). In this sample, the proportion of women was 55.1% ($n = 1718$) and

significantly higher than in the LPA-sample ($\chi^2_{(1)} = 5.01$, $p = .025$). Further, the proportion of those born in 1959 was significantly higher in the sample for longitudinal analysis (45.9%; $n = 1430$; $\chi_{(1)} = 5.39$, $p = .020$).

### Calculation of work indices

For the determination of the work profiles, a procedure was adopted as conducted by Eurofound with data from the „6th European Working Conditions Survey "[14]. In a first step, the seven work exposure indices used by Eurofound were re-constructed with variables available in the lidA-study. Two further indices, "continued education" and "quality of leadership", were added because they were considered to represent distinct work exposures in German working life. The resulting nine indices are supposed to represent the totality of resources and demands of work exposure and are displayed in Table 2. Apart from using single-item measures such as shift work or the amount of working time being exposed to adverse physical exposure, selected scales derived from the „Copenhagen Psychosocial Questionnaire "[COPSOQ [24]; and items of the „Effort-Reward-Imbalance Questionnaire "[ER I[25]; were used for index construction. The final nine indices correlated in most instances with $r < \mid .10 \mid$ and always below $\mid .50 \mid$.

In order to calculate a score per index, at least half of the respective items and scales had to have valid values. After weighting with the factors indicated in Table 2, all raw scores for the items and scales contributing to one index were summed up. Finally, the sum scores were transformed to an index ranging from 0 (adverse exposure) to 100 (favourable exposure). The earnings index was calculated as the monthly net equivalised household income according to OECD [26]. Regarding scale type, ordinality was assumed in the subsequent analyses for "physical exposure", "working time quality" and "prospects", while "continuous education" was treated as nominal and the remaining indices as metric. The proportion of missing values was below 1.9% for eight indices. However, for income it was 19.9% which corresponds to the mean refusal rate in Europe to disclose earnings [14]. As a consequence, missing values were replaced by means of stochastic regression imputation [27] to handle systematic selection and to assure a high number of participants.

### Work-related outcomes

Posterior profile membership was linked to selected, commonly used work-related outcome measures over time to demonstrate distinctness and thus validity of the latent profiles identified in the prior analysis steps. This procedure was done analogous to "step 3 analysis" in LPA [28]. Here, physical and mental health, work ability and work-privacy-conflict were chosen as so-called external outcomes to conceptually reflect this procedure as done by Eurofound [14]. Physical and mental health were assessed by the respective SF-12 short scales, the physical component summary and the mental component summary as described by Nübling et al. [29]. Work-privacy-conflict was measured by a 2-item COPSOQ scale covering both the mental strain as well as the time strain component of a conflict between work and private life [30]. The second dimension of the Work Ability Index [31] was used as a measure for work ability. This two-item scale, ranging from 2 (=no work ability) to 10 (=optimal work ability), assesses the estimation of one's own mental and physical work ability. It has been validated and recommended recently for the use in epidemiological studies [32].

**Table 2** Composition of indices, weighting of contents and descriptive statistics

| Index | Scales/ items included (weighting factor) | Descriptives |
|---|---|---|
| Physical exposure | Proportion of working time: sitting (1); bending, kneeling/ lying/working above head (1); lifting heavy loads (1); repetitive movements (1) | 50.0 (50.0)[a] |
| Working time quality | Shift work (1); night shifts per month (1); having another job (1) | 100.0 (33.3)[a] |
| Work intensity | COPSOQ-Scale „quantitative demands – 4 items "(2); frequency of interruptions at work (1) | 47.6 (25.5)[b] |
| Skills & discretion | COPSOQ-Scale „influence at work – 3 items "(1); COPSOQ-Scale „possibilities for development – 3 items "(1) | 50.8 (21.6)[b] |
| Social environment | COPSOQ-Scale „support from colleagues – 2 items "(1); ERI item: receiving acknowledgment from colleagues (1) | 69.7 (29.0)[b] |
| Quality of leadership | COPSOQ-Scale „quality of leadership – 3 items "(3); ERI-item stress due to lack of recognition from superior (1) | 61.1 (22.2)[b] |
| Continued education | Participation in continued education in the last 12 months: 0 = no, 1 = yes | .20[c] |
| Earnings | Monthly equivalised household net income | 16.2 (7.5)[b] |
| Prospects | Open ended or fixed-term work contract (1); recent job cuts/dismissals in enterprise (1); risk of losing one's job (1); promotion prospects (1); chances for occupational advancement (1) | 60.0 (20.0)[a] |

*Note.* a = median and interquartile range are displayed for ordinal indices; b = mean and standard deviation are displayed for metric indices; c = proportion in the sample

### Statistical analyses

In a first step, a „latent profile analysis "[33] was conducted in LatentGOLD 5.1 [Statistical Innovations, Belmont MA, USA] to identify different patterns of work exposure among subjects on a latent variable that comprises *k* classes (or in our case: profiles). In classical LPA, all constituting indicators are metric, yet in the present study the scale type was mixed as outlined above and has been modelled accordingly in the final analyses. The LPA is model-based and assumes that associations between the observed indicators can be explained by a latent variable with *k* profiles comprising different manifestations of the indicators chosen [16]. After model estimation, classification of a heterogeneous sample into homogeneous subgroups (the *k* profiles) is possible by means of their respective posterior profile membership probabilities, and thus unobserved heterogeneity in the sample can be described [28]. Model selection was based on three premises: Formal criteria for model selection were the Akaike- (AIC) and the Bayesian information criterion (BIC), where lower values indicate better model fit [28]. Secondly, parsimonious solutions were favoured with profiles sufficiently differentiating among employees. Finally, a plausible interpretability guided the selection of the optimal number of profiles [16, 34]. Data preparation and subsequent analyses were done with IBM SPSS Statistics 25. These included $\chi^2$-tests to examine the demographic distribution across profiles. Correlation analysis confirmed that the nine single indices correlated differently and in varying amounts with the health components, work-privacy-conflict or work ability. In almost all instances, the correlation coefficients were significant ($p < .001$) ranging from small to medium size. This correlational pattern prompted further investigation of differences between profiles in all instances. Mixed-design ANOVA's were performed to test for mean differences between the profiles on the outcomes across three time points. Beforehand, inspection of the outcome distributions yielded skewness values ranging from − 0.70 to 0.43, and kurtosis values ranging from 2.42 to 3.48, thus indicating acceptable distributional properties for further analyses. The longitudinal analyses were done for those with valid data for all three time points. This way, within and between group effects can be simultaneously identified without having to consider attrition and health-related selection effects. Greenhouse-Geisser corrections were used because sphericity was violated for all work-related outcomes except for mental health. Post-hoc comparisons were Bonferroni-adjusted to a significance level of .05. Effect sizes for main and interaction effects with $\eta^2 \geq .01$ were classified as small, $\eta^2 \geq .06$ as medium and $\eta^2 \geq .14$ as large [35].

## Results

### Determination and interpretation of profiles

The LPA was conducted with an increasing number of profiles. The AIC and BIC did not reach a minimum up to a solution with 10 profiles. As both criteria dropped in smaller steps for solutions with more than five profiles, this solution was favoured (AIC/BIC – four profiles: 322421.1/323109.2, five profiles: 321545.7/322301.1, six profiles: 320995.8/321818.7 and seven profiles: 320445.6/321335.9). The fifth group in the five-profile solution was extremely small (about 3%). Nonetheless, it was deemed meaningful because it had already emerged in the four-profile solution and remained stable across all further solutions.

In solutions with six or more profiles, they mostly differed by one index only, going along with small, instable profiles and impeding a straightforward interpretation. The stability of the favoured five-profile solution was investigated by recomputing the LPA in three randomly drawn subsamples containing 50% of the original sample each [28]. In the first and third subsample, AIC and BIC did not reach a minimum whereas in the second one, both indicators suggested a nine-profile solution. In all subsamples, the numeric decrease for AIC and BIC was smaller for solutions with more than five profiles and the percentage distribution of employees in the five profile solutions was comparable to that in the full sample analysis, thus indicating relative stability. In the full sample, mean posterior profile probabilities ranged between .84 and .94 across the final five profiles indicating fairly reliable classification [36]. Profile characteristics and group sizes of the final five-profile solution are shown in Fig. 1 and described as follows:

Nearly one of five older employees (18.7%) was assigned to the "Poor Quality" (PQ) profile, a group of predominantly manual workers characterised by unfavourable work exposures for almost all indices. The "Relaxed Manual" (RM, 30.0%) also comprise of manual workers with a profile resembling that of PQ but with favourable manifestations of the indicators for social interaction and with lowest work intensity. The "Strained non-Manuals" (SnM, 15.5%) conceptually depict the complement to the RM profile exhibiting lower-than-average scores for social work environment and prospects while work intensity is clearly highest (red low z-score). The large non-manual group of the "Smooth Running" (SR, 32.9%) is characterised by favourable non-physical work exposures with respect to all indices except work intensity. The profile of the small non-manual group "High Flying" (HF, 2.9%) is almost identical with that of the SR, apart from the extremely high earnings in this subgroup and higher work intensity.

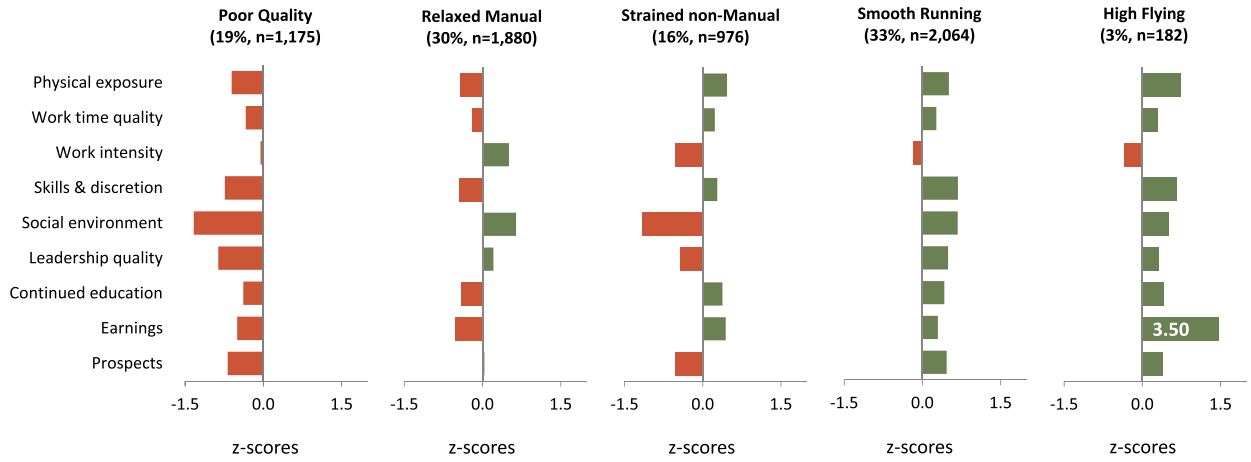



**Fig. 1** Relative manifestation (z-values) of the indices across profiles; red bars to the left indicate unfavourable manifestation, green bars to the right indicate favourable manifestation; due to space restriction the earnings bar of the High Flying profile was shortened and the actual z-value (3.50) was displayed

### Demographic characteristics across profiles

The proportion of employees born in 1965 was slightly above 50% across all profiles thus representing the overall distribution in the sample, $\chi^2_{(4)} = 2.53$, $p = .639$. There were differences for the proportional distribution of sex, educational level [37] and weekly working hours, as well as the requirement level of task complexity and occupational area [38] (cf. Table 3).

The proportion of women was above 50% in all profiles except in the HF where the relation was reversed. With respect to education, task complexity level and also occupational area, the distribution was quite similar for two manual profiles PQ and RM, and also for two non-manual profiles SnM and SR. The first predominantly cover participants with low and medium level education, and with low and medium task complexity levels. Occupational areas with higher prevalence in these profiles are agriculture, production, logistics and safety and certain services. The second, SnM and SR, mainly cover the upper range of education and task complexity level in their groups. Full time work is most and part-time work less than 20 h/week is least prevalent. Here, natural and IT sciences, business organisation and administration, the health and social sector and humanities are more prevalent. The HF show the largest proportions of workers with high education and task complexity, while working part time is less frequent. Almost half of all participants assigned to this profile work within business organisation and administration.

### Differences in work-related outcomes

There were substantial group differences in all work-related outcomes investigated and also diverging profile patterns for the time course of the outcome variables over seven years (see Table 4 and Fig. 2). Regarding physical health, profile membership ($F_{(4;\ 2844)} = 43.10$, $p < .001$, part. $\eta^2 = .06$) and time ($F_{(2;\ 5658)} = 42.56$, $p < .001$, part. $\eta^2 = .02$) showed a significant main effect. The profile*time interaction was not significant ($F_{(8;\ 5658)} = 1.60$, $p = .119$, see Fig. 2 a). All profiles differed significantly from each other in all three instances with a plausible gradient "good to poor health" from HF, SR and SnM to the manual profiles RM and PQ. For all profiles, the physical health means did not change significantly between 2011 and 2014 but had decreased by 2018, except for the HF, where the small group size and high dispersion prevented significance of changes over time.

Also for mental health, significant main effects for profile membership ($F_{(4;\ 2844)} = 24.17$, $p < .001$, part. $\eta^2 = .03$) as well as time ($F_{(2;\ 5688)} = 16.73$, $p < .001$, part. $\eta^2 = .01$) were evident. Here, the profile*time interaction was significant ($F_{(8;\ 5688)} = 2.44$, $p = .013$, part. $\eta^2 = .00$, see Fig. 2 b). However, the effect size did not indicate practical significance. For mental health, all profiles exhibited a dip in the 2014 assessment. In contrast to the findings for physical health, the profiles showed more group overlap with respect to mental health and a diverging gradient: Highest scores were found for the SR, RM and also HF and lowest for SnM and PQ.

With respect to the work-privacy-conflict a significant main effect for profile membership was found ($F_{(4;\ 2887)} = 31.88$, $p < .001$, part. $\eta^2 = .04$), but not for time ($F_{(2;\ 5735)} = 1.69$, $p = .184$). However, the profile*time interaction was significant but with low effect size ($F_{(8;\ 5735)} = 6.43$, $p < .001$, part. $\eta^2 = .01$, see Fig. 2c). The PQ and SnM exhibited the highest work-privacy-conflict in all instances and showed a decrease from 2011 to 2014.

**Table 3** Distribution of older employees across profiles (percentage)

| | Poor Quality ($n = 1175$, 18.7%) | Relaxed Manual ($n = 1880$, 30.0%) | Strained non-Manual ($n = 976$, 15.5%) | Smooth Running ($n = 2064$, 32.9%) | High Flying ($n = 182$, 2.9%) |
|---|---|---|---|---|---|
| Sex: $\chi^2_{(4)} = 14.74$, $p = .005$ | | | | | |
| Male | 48.2 | 44.1 | 45.4 | 48.9 | 54.4 |
| Female | 51.8 | 55.9 | 54.6 | 51.1 | 45.6 |
| Educational level: $\chi^2_{(8)} = 774.95$, $p < .001$ | | | | | |
| Low | 36.3 | 37.9 | 13.1 | 15.7 | 5.5 |
| Medium | 54.7 | 54.0 | 55.2 | 53.3 | 47.0 |
| High | 9.0 | 8.1 | 31.6 | 31.0 | 47.5 |
| Job task requirement level: $\chi^2_{(12)} = 1401.07$, $p < .001$ | | | | | |
| Un–/Semiskilled task | 15.6 | 16.6 | 1.9 | 1.6 | a |
| Skilled task | 68.7 | 70.1 | 44.4 | 44.6 | > 20.0[a] |
| Complex task | 10.7 | 8.9 | 25.7 | 24.0 | 23.3 |
| Highly complex task | 5.1 | 4.4 | 28.0 | 29.8 | 50.0 |
| Weekly working hours: $\chi^2_{(8)} = 264.54$, $p < .001$ | | | | | |
| Full-time (> 34 h/week) | 69.4 | 59.6 | 74.8 | 74.5 | 88.8 |
| Part-time (20 to 34 h/week) | 19.9 | 22.4 | 20.9 | 19.8 | > 5.0[a] |
| Part-time (< 20 h/week) | 10.8 | 18.0 | 4.3 | 5.6 | a |
| Occupational area: $\chi^2_{(32)} = 872.79$, $p < .001$ | | | | | |
| Armed forces personnel | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Agriculture, forestry, gardening and fishing | 2.0 | 2.0 | 0.5 | 1.0 | 0.0 |
| Production of raw materials and goods, and manufacturing | 27.5 | 24.3 | 15.3 | 17.0 | 9.4 |
| Construction, architecture, surveying, and technical building services | 4.5 | 7.2 | 3.1 | 4.8 | 3.3 |
| Natural sciences, geography, and informatics | 1.5 | 2.0 | 5.8 | 5.8 | 7.2 |
| Traffic, logistics, safety and security | 20.6 | 18.6 | 4.2 | 3.9 | 3.3 |
| Commercial services, trading, sales, hotel business and tourisms | 12.0 | 13.4 | 8.1 | 9.6 | 8.9 |
| Business organisation, accounting, law, and administration | 13.5 | 13.5 | 30.0 | 29.3 | 48.3 |
| Health care, the social sector, teaching and education | 16.9 | 18.1 | 28.7 | 25.0 | 15.0 |
| Philology, literature, humanities, social sciences and economics, media, art, culture and design | 1.6 | 0.9 | 4.3 | 3.7 | 4.4 |

*Note.* $N = 6277$; [a] Small cell numbers cannot be displayed for reasons of data protection

In contrast, the SR and especially the RM had the lowest but increasing levels for this outcome between 2011 and 2018. The HF remained relatively stable over time ranking between the higher and lower scoring profiles.

Finally, also for work ability a distinct profile pattern was found. All effects were significant (see Fig. 2 d) – the main effect for profile affiliation ($F_{(4;\ 2851)} = 62.06$, $p < .001$, part. $\eta^2 = .08$), the main effect over time ($F_{(2;\ 5630)} = 36.23$, $p < .001$, part. $\eta^2 = .01$) and also the profile*-time interaction ($F_{(8;\ 5629)} = 320$, $p = .001$, part. $\eta^2 = .00$). The profile gradient was widely constant over time with highest work ability scores for HF and SR, followed by RM and SnM, and with low scores at all instances for PQ. Work ability decreased for all profiles over time except among the SnM.

## Discussion

In this study, a typology of contemporary work exposure among older employees in Germany was established, based on recent representative data. The procedure was comparable to the approach performed by Eurofound [14]. The appropriateness of both, the chosen indices

**Table 4** Descriptive statistics for work-related outcomes by work profile over 7 years

| | Physical health | Mental health | Work-privacy-conflict | Work ability |
|---|---|---|---|---|
| Profile | *M (SD)* | *M (SD)* | *M (SD)* | *M (SD)* |
| Poor Quality | | | | |
| *n* | 478 | 478 | 489 | 476 |
| 2011 | 47.1 (9.1) | 49.6 (10.4) | 43.7 (27.5) | 7.4 (1.5) |
| 2014 | 47.4 (8.8) | 48.6 (10.5) | 39.5 (27.4) | 7.5 (1.5) |
| 2018 | 45.9 (8.7) | 49.8 (10.6) | 40.1 (27.0) | 7.2 (1.7) |
| Relaxed Manual | | | | |
| *n* | 777 | 777 | 784 | 779 |
| 2011 | 49.3 (8.8) | 53.1 (8.9) | 27.8 (26.2) | 8.1 (1.4) |
| 2014 | 48.9 (8.9) | 51.8 (9.3) | 30.2 (26.5) | 7.9 (1.4) |
| 2018 | 46.5 (9.2) | 52.0 (9.7) | 32.1 (26.7) | 7.7 (1.5) |
| Strained non-Manual | | | | |
| *n* | 473 | 473 | 478 | 474 |
| 2011 | 50.7 (8.7) | 49.7 (9.9) | 44.0 (27.4) | 7.9 (1.6) |
| 2014 | 50.6 (8.9) | 48.7 (10.3) | 39.5 (27.3) | 7.8 (1.5) |
| 2018 | 49.8 (9.2) | 50.8 (9.3) | 40.1 (26.8) | 7.7 (1.5) |
| Smooth Running | | | | |
| *n* | 1031 | 1031 | 1051 | 1039 |
| 2011 | 52.0 (8.1) | 53.6 (8.9) | 32.6 (25.4) | 8.5 (1.3) |
| 2014 | 51.5 (8.6) | 51.7 (10.0) | 33.9 (26.0) | 8.3 (1.4) |
| 2018 | 49.9 (9.2) | 52.8 (9.4) | 35.8 (25.7) | 8.1 (1.4) |
| High Flying | | | | |
| *n* | 90 | 90 | 90 | 88 |
| 2011 | 54.0 (7.4) | 52.3 (10.2) | 37.6 (27.1) | 8.8 (1.2) |
| 2014 | 54.0 (7.0) | 50.4 (11.0) | 37.5 (25.3) | 8.4 (1.4) |
| 2018 | 52.7 (7.8) | 52.3 (10.0) | 38.8 (28.1) | 8.1 (1.6) |

and the final profiles, was assessed by means of theoretically and empirically established work-related outcomes. In summary, the findings suggest the existence of five distinct profiles of work exposure among the German baby boomer workforce. This helps scientific and policy stakeholders to better conceive the currently employed baby boomer generation in Germany in its holistic work situation.

### Profile summary

The first profile identified is that of *Poor Quality* (PQ) work. Almost 20% of all workers belong to this profile which is characterised by least favourable exposures for eight of nine work indices. It is dominated by mean low qualification levels and mainly manual jobs and professions. The group exhibits the most adverse scores for all work-related outcomes, be it health, the work-privacy-conflict or work ability.

The *Relaxed Manual* (RM) profile covers 30% of all workers. Like the PQ profile it is characterised by, on average, low qualification levels, mainly manual jobs and professions and several poor work indicators. The differences, however, are the more favourable manifestations of the social work exposure indicators and the lowest work intensity of all profiles. These positive exposures are reflected by better mental health and very low work-privacy-conflict scores. Physical health, however, is rather low.

With respect to the manifestation of the work exposure indices, the *Strained non-Manual* (SnM) constitute the inverse counterpart of the RM with predominantly non-manual work, adverse scorings for social work indicators, work intensity, and also prospects. Sixteen percent of all workers belong to this group, mainly from business administration and organisation, the health and social sector and also scientists. The SnM profile shows adverse mean scores for mental health and work-privacy-conflict, while physical health and work ability are on average level.

The largest profile (33%) is the *Smooth Running* (SR) with an all-favourable work exposure profile opposite to that of PQ, except for above average work intensity. The

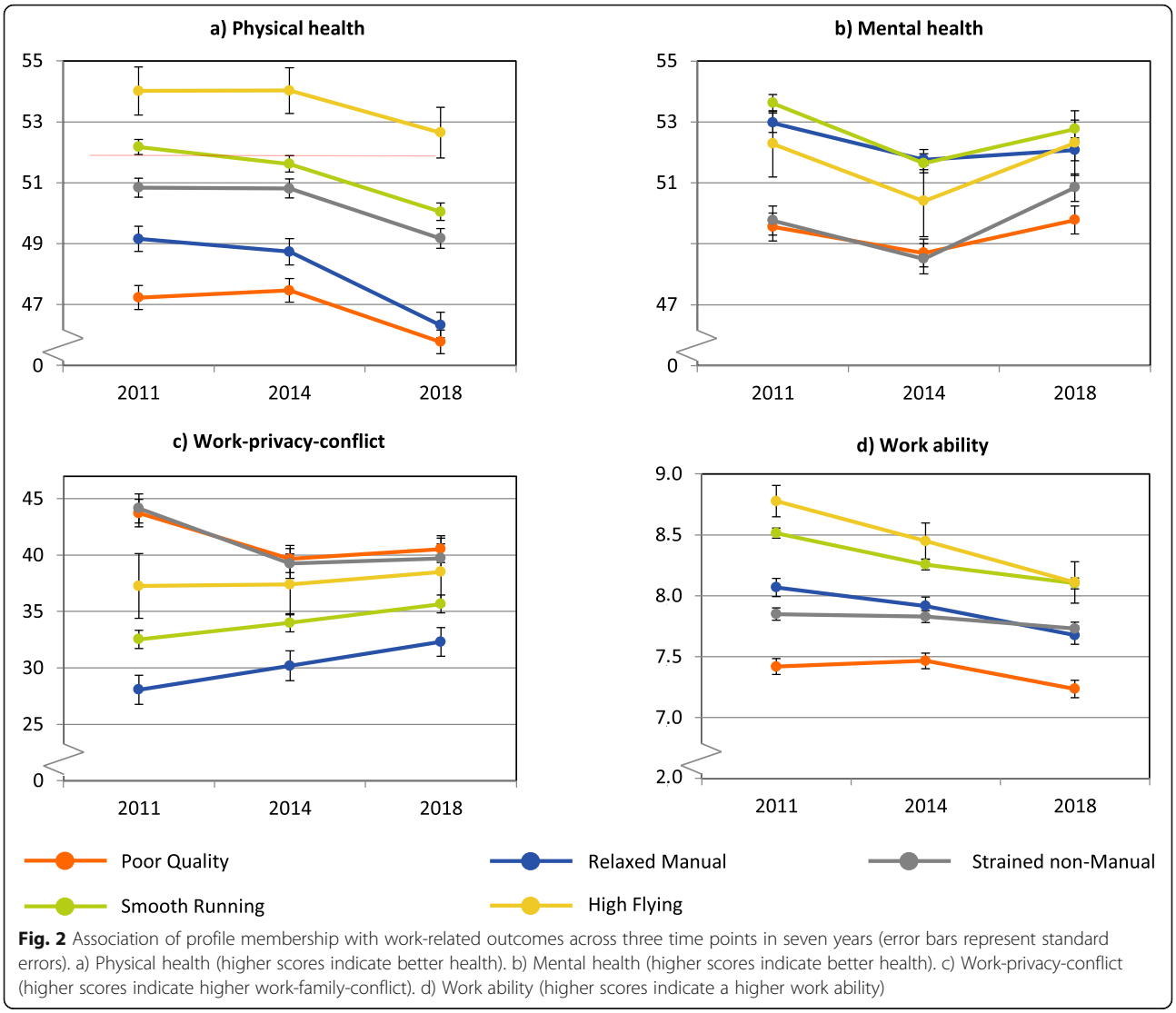



**Fig. 2** Association of profile membership with work-related outcomes across three time points in seven years (error bars represent standard errors). a) Physical health (higher scores indicate better health). b) Mental health (higher scores indicate better health). c) Work-privacy-conflict (higher scores indicate higher work-family-conflict). d) Work ability (higher scores indicate a higher work ability)

predominant professions are similar to those of SnM, yet, in contrast to SnM, mental health is highest among SR, work ability rather high and the work-privacy-conflict rather low.

The smallest profile (3%) is that of the *High Flying* (HF), the profile with the most favourable work exposure manifestations except for rather high work intensity. The very high score for earnings is a distinct feature of this profile. Specifically, business organisation and administration, but also scientists are more frequently found in this group. While scores are highest for physical health and work ability, the profile reaches medium group levels for mental health and work-privacy-conflict only.

### Relation to further profiles

There is substantial accordance between the profiles identified here and the profile patterns of the three studies using comparable approaches (cf. Table 1). Not surprisingly, the PQ profile finds equivalents in all studies, the "few rewards" profile in Canada [15], the Flemish "high stress" [13] and the European "poor quality" profiles [14]. The RM profile identified in this study is to a certain degree equivalent to the Canadian "relationships and balance" profile [15], the "passive manual" in Belgium [13] and the "active manual" identified by Eurofound [14]. The SnM profile has an overlap with the "under pressure" profile by Eurofound [14]. The favourable SR profile would match the combination of the profiles "total rewards" and the "economic and support" in the analysis of Canadian workers [15] and the Flemish "low stress" profile [13]. However, it does not match a profile in the Eurofound analysis, although a group of identical names exists. The Eurofound SR profile shows favourable social and physical working conditions and – in contrast to the SR profile in this

study – low discretion and very low earnings, coupled with very low work intensity [14]. Finally, the HF shows a similar profile to the "high flying" identified by Eurofound [14] with favourable ratings on all indicators, very high earnings and some exposure to work intensity. However, while this profile constitutes an exceptional work exposure constellation in this study of workers in Germany (3%), it covers 21% of all participants in the Eurofound survey. Thus, the SR and the HF in the German LPA assessment do not match occupational group profiles identified by Eurofound to the same degree as the other profiles do.

### European vs. national profiles

The overall high correspondence of the profile pattern in this study with that from Eurofound may not be surprising as the two studies are quite similar in the conceptual understanding of work and work exposure. They also share similarities in the assessment, i.e. the work indicators selected, their underlying items and, finally, the predominant application of continuous scales in the analysis. The differences between the findings of the two studies may have a simple explanation: The Eurofound analysis is based on a Europe-wide sample with many work quality indices exhibiting a European North-West / South-East gradient in the expected direction [14], which is reflected by the profile distribution. The Eurofound profiles *high flying*, for example, is highly prevalent in North-West Europe (e.g. 39% of all workers in Denmark) and rare in the South-East (e.g. 5% in Greece); similarly the *under pressure* profile. In contrast, the Eurofound profile *smooth running* is characteristic for some central and south European countries with comparably low income (e.g. Bulgaria 47%). Their *poor quality* profile is characteristic for South-East Europe (e.g. 54% in Romania) but not for North-West Europe (e.g. 5% in Finland). Certainly, this uneven distribution of work quality across Europe will influence potential profiles obtained as it may generate characteristic profiles for work in certain economic regions, thereby enabling a European perspective, for example for European social policy. When it comes to the national point of view, however, profiles based on national representative samples are more appropriate to reasonably reflect the target group of interest.

### Relation of profiles to the work-related outcomes

By linking profile assignment to external outcomes, the distinctness of the profiles was confirmed due to observable differences across all of them. For all four work-related outcomes, significant differences were found between the profiles. PQ group membership was associated with adversity with respect to all work-related outcomes considered in this study, indicating a genuine risk group for continued work and employment. At the other extreme, there is no occupational profile with exclusively favourable outcome manifestations. According to their ratings, the HF are markedly physically fit accomplishers, but medium level scorings for mental health and work-privacy-conflict indicate that this group does not constitute an overall favourable group. This is in line with the findings presented by Eurofound for the equivalent HF profile [14]. The large SR profile indicates a group with high resources: good mental health and second best in all other outcomes. Again, this profile finds its equivalent in the Eurofound profile with same name, but with poor work-life balance [14]. The profile with lowest work-privacy-conflict identified in this study is the RM which also exhibits good mental health. This is a group with a favourable social work environment and markedly lowest work intensity. However, the mean score for physical health is low, which may be assumed to substantially reflect working-life-long physical work exposure. It is notable that the two groups with low mean scores for the social work environment indicators show most adverse scores for mental health, work-privacy-conflict and also work ability. Unfortunately, Eurofound does not differentiate between mental and physical health. This, in turn, was done by Vanroelen et al. [13], displaying the profile main effects for emotional problems and musculoskeletal complaints. Yet, the profiles follow widely the same ranking for both outcomes with the low stress profile exhibiting the most and the high stress the least favourable effects.

When observing time effects, a mean deterioration of physical health over seven years was found. With respect to mental health, an unexpected dip in the 2014 assessment was observed for most profiles which may partly be attributed to the fact that the wave 2 assessment was predominantly performed in late winter. Work ability deteriorated strongly, especially for the groups with initially high work ability. With respect to work-privacy-conflict all groups converged over time. The profile*time interactions were significant for all outcomes except physical health, but always with low effect size. Thus, in this study no indications for profile membership were found which at one point in time clearly predict change of work-related outcomes in the future. However, it cannot be ruled out that this will be the case in future assessments when the workers' age increases and thereby also risks for health and work ability. Limitation of space and aims of this publication do not allow for a deeper discussion of the profile*time interactions with respect to the work-related outcomes.

What has not been considered in the analyses yet is the frequency and the preventive potential of the occupational change in the sample. Some workers may find themselves in *job lock* or *stuck at work* situations [39]

not being able to modify their adverse work situation. Others, however, might benefit from occupational change, which comprises change of profession, employer or tasks. Bujacz et al. [8] have found systematic change over a six-year period mainly from more demanding to lesser demanding clusters characterised by psychosocial work exposure. Membership in supportive clusters was found to be fairly stable.

### Translation into policy needs

The originality and strength of the person-centred, typological approach in occupational epidemiology primarily lies in its preoccupation with the social distribution of work exposures and its structuring [13]. This study identified common ways in which older employees in Germany characterise their perception of work. These common perceptions are reflected by the five profiles identified in this study, which now may be considered typical for the older socially insured workers in this country. This profile pattern has some contextual overlap with that of other studies [13, 14]. Yet, it also shows individual features which may in part be explained by the fact that - in contrast to further studies - a rather homogenous sample has been investigated, namely socially insured older workers in one country. The findings also show that profile membership is reflected by substantial and plausible differences on four work-related outcomes. Thus, it may be assumed that "it matters" whether an individual is more likely to fit into the one or the other profile.

Numerous surveys in Germany have been used to identify poor working conditions and their associations with health and wellbeing [40, 41]. In contrast to that, and for the first time in Germany, the findings from this study allow to postulate that working groups exposed to distinctly poor-quality or high-quality work-situations exist, and that these can be quantified and characterised. Accordingly, one third of all older workers in Germany work under predominantly poor working conditions, the PQ and SnM, clearly associated with poor work-related outcomes. At the other extreme, another third of workers finds itself in profiles indicating rather favourable overall working situations (SR and HF), mostly positively related to health, work ability and work-privacy-conflict. Finally, there is one group which covers the remaining 30% of older workers, the RM: Here, both adverse and favourable exposures are found and work-related outcomes indicate both substantial resources and risks.

The knowledge of the five profiles identified may help to understand the older working population to whom the transition from work to retirement becomes increasingly apparent. This transition is not only complex, but also a process encompassing the notion of *leaving* or *staying* in employment [4]. In times of extending working lives, the interest of policy is usually focused on *leaving*, i.e. the timing of retirement. Yet, the findings in this study imply that for some groups of older workers the *staying* may constitute substantial personal challenges. This specifically applies to those 20% of all older workers who belong to the PQ profile, and possibly the SnM, an additional 14%. On the other hand, being aware of the complexity of retirement, one should not assume that membership to a favourable profile such as SR, HF, or RM automatically indicates late retirement, as in Germany an early exit culture still prevails [42].

#### *Strengths and limitations*

According to the findings in this study, about one third of all workers assessed in this study belongs to one of the two clusters with predominantly less favourable work exposures, the PQ and the SnM. In line with this is the observation that the PQ scores worst on all work-related outcomes assessed from wave 1 throughout wave 3, in most instances followed by the SnM. For a number of reasons this does not necessarily mean that all workers in these profiles were dissatisfied with their work or did not find it meaningful. Firstly, it needs to be considered that when presenting the manifestation of the indices across profiles as in Fig. 1 z-transformed scores are shown. Z-scores are relative scores, indicative of the ranking within the total sample and not of a defined score or cut-off known to represent adverse exposure. However, the accumulation of low z-scores for work quality indices in a profile (such as in PQ) is still indicative of clearly less favourable exposure than that in other profiles. Secondly, while the work-health associations identified for the profiles are mostly in the expected direction and causality seems plausible, we did not investigate this in our study, even if the study is of longitudinal nature. In fact, a reciprocal relationship and even feedback loops are also likely to contribute to the findings: the worker's health may positively or negatively affect their work, which in return may affect the individual worker i.e. with respect to attitudes, behaviours and health, with the potential for further feedback loops [43]. Finally, some workers may not perceive "poor" work as "poor", possibly because their work represents what they have been experiencing throughout their working life and which has shaped their expectations. When interpreting the results, one has to keep in mind that the work indices assessed are measured at a cross-section in time, yet, they are assumed to reflect chronic work exposure of relatively enduring character. The stability of the work exposures and thereby profile allocation needs to be assessed in further studies.

Methodically, the stochastic regression imputation chosen to replace missing values mainly on the earnings

indicator may have several advantages over more convenient methods like mean imputation. Nonetheless, it is still limited to being a single imputation method and the standard errors of the imputed values tend to be underestimated because an uncertainty component is not included in the prediction of the missing values [27]. Unfortunately, the use of a single data set was necessary for analyses with two statistic programs which prevented application of more advanced imputation methods like multiple imputation. In sum, the chosen imputation method served as a pragmatic trade-off between maximum possible reduction of potential bias due to missing values and technical aspects of the analysis process.

The LPA conducted here is advantageous over deterministic clustering techniques, because posterior profile assignment is probability-based and not based on e.g. distance measures [44]. Here, the degree of dissimilarity of each individual with the identified classes is quantified because the highest probability of belonging to a certain cluster seldom equals 1.0. This represents a more appropriate localisation of the individual work exposure relative to all other workers in the sample under study. Nonetheless, one has to keep in mind that this advantage is obscured by the posterior profile assignment for practicability reasons.

As for the outcome measures chosen to validate the identified profiles, parametric tests were applied to detect differences over the course of three assessments. In ANOVA violations of the underlying assumptions can compromise analyses which is why the outcome distributions were inspected beforehand. Slight deviations from normality were evident but of acceptable extent. Moreover, the respective group sizes were large enough to yield results that can be considered reliable, as the ANOVA is robust when assumptions are violated but minimum group sizes are ensured [45].

## Conclusions

In sum, the findings indicate that a differentiated view on the older work force should be applied when it comes to the work-retirement transition. From a policy perspective, the results imply that the political interest should not be limited to the timing of retirement, but also cover quality of work and personal life during the last working years - specifically in the considerable occupational risk groups identified in this study. Broad evidence from different fields of academic research indicates that current extending working life policies bear substantial risks for increasing social inequalities and current empirical studies confirm this with recent data [46]. Here, monitoring is needed - at an early stage - to identify groups of workers representing losers or winners in the transition process. For this, the five work profiles identified in this study may constitute crucial clusters needed to reliably reflect the over-all work exposure patterns in the older work force in Germany.

Research should continue to characterise these five groups with respect to further outcomes, such as economics, financial and social wellbeing, motivation and employment. Further scientific monitoring of the profiles is needed for the early detection of adverse trends in all respects. Not least, the pathways from work to retirement and the individual and social effects related to them will require substantial scientific attention. Finally, it may be of scientific, social and also organisational interest to investigate frequency and consequences of older workers' change between the five profile groups identified in this study.

### Abbreviations

AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; COPSOQ: Copenhagen Psychosocial Questionnaire; ERI: Effort-Reward-Imbalance Questionnaire; HF: High Flying; LCA: Latent Class Analysis; lidA: Leben in der Arbeit; LPA: Latent Profile Analysis; PQ: Poor Quality; RM: Relaxed Manual; SnM: Strained non-Manual; SR: Smooth Running

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### Authors' contributions

HMH and MS designed the study, MS performed the analyses, HMH and MS have written the first draft of the article, ME and JP contributed to the development of the manuscript. HMH, MS, ME and JP critically reviewed and revised the manuscript and approved the final article. The authors read and approved the final manuscript.

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### Availability of data and materials

An anonymised Scientific Use File containing data of the first two waves of the lidA study is available by request for scientific purposes at the Research Data Centre (FDZ) of the German Federal Employment Agency at the Institute for Employment Research, IAB, Nuremberg, Germany (https://fdz.iab.de/de/FDZ_Individual_Data/lidA.aspx). Data from the third wave of the study is not publically available yet due strict social data protection requirements. The publication of an approved Scientific Use File covering all three waves of the lidA study is planned for 2023.

### Ethics approval and consent to participate

Each participant was fully informed about the aim and procedure of this study in written prior to giving verbal consent to participate in this study. The verbal consent was then documented by the interviewer. Willingness for continued participation (to wave two and three) required written consent with an additional verbal consent (documented) at the beginning of the respective interview. This practice has proven to be useful is surveys and is commonly followed in social survey research in Germany, because a priori written consent is regarded to lead to uncontrollable response bias limiting the validity of the results. It is following the strict data protection requirements obligatory when using social register data ("Sozialdaten") in Germany and of the European General Data Protection Regulation (GDPR). The procedure, including verbal and written consenting, and all written documents sent and handed to the participants were approved by the state privacy advocate of the Federal Ministry of Labour and Social Affairs (Data protection contracts dating from 07/2010 [8104.1–14], and 27/09/2017 [8102 .9–23]). Ethical approval for study design and performance, including verbal

and written consenting, was obtained from the Ethics Committee of the University of Wuppertal (dated from 05/12/2008 [Sch/Ei Hasselhorn] and 20/11/2017 [MS/BB 171025 Hasselhorn]).

### Consent for publication

The manuscript does not contain any individual person's data in any form.

### Competing interests

All authors declare that there is no conflict of interest.

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ARTICLE

# Job quality trajectories among baby-boomers in Germany and their consequences for the motivation to work – results from the lidA cohort study

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**Abstract**

In light of a large proportion of older workers leaving the German labour market in the near future, policy makers aim to extend working lives to ensure sustainability of the social security system. In this context, safe and healthy working conditions are considered a precondition for encouraging employment participation. To understand better the role of the work environment in pre-retirement years, we draw upon an established model of five job quality profiles for the German ageing workforce. We explored seven-year profile development and linked selected manual and non-manual job quality trajectories to the motivation to work (MTW) using data from the 2011, 2014 and 2018 assessments of the lidA cohort study (valid N = 2,863). We found that older workers shifted to physically less-demanding profiles. Individual profile stability was prevalent among one-third of the workers. In 2018, there was a higher MTW when job quality remained favourable or improved early, while later improvements were associated with lower MTW. Early deterioration of job quality was associated with lower MTW levels among workers with non-manual trajectories only. The results highlight the dynamic job quality situation of the older German workforce and the importance of adopting a person-centred perspective when investigating working conditions and its effects. They further underline the need to consider quality of work when designing and implementing strategies to extend working lives.

**Keywords:** accumulation; working conditions; older worker; prospective cohort study; extended working lives; social inequality; retirement; motivation to work

## Background

Accelerated population ageing and its economic dynamics are major challenges as they put pressure on the national pension and social security systems of almost all Western countries (Börsch-Supan *et al.*, 2003). According to the Organisation for

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Economic Co-operation and Development (OECD), the number of individuals in Germany aged 65+ per 100 people of working age (20–64 years) is expected to increase from 36.5 in 2020 to 58.1 in 2050. It is estimated that it will become stable at around 60.0 by 2080 (OECD, 2019: 175). This is the seventh highest projected old-age to working-age ratio among the European Union (EU) countries. To attenuate the fiscal consequences of an ageing workforce, particularly in the next years, German policy makers aim to extend working lives (EWL), *e.g.* by raising employment participation among underrepresented social groups such as women, migrants or those of older working age, and by raising the statutory retirement age for all employees (Federal Ministry for Economic Affairs and Energy, 2016: 37). Although employment rates among older workers in Germany have increased substantially between 2009 and 2019 (age group 55–59: from 69.9% to 81.8%; age group 60–64: from 38.6% to 61.8%; Federal Office of Statistics, 2020), German policy regards continued promotion of sustainable working conditions necessary to improve health and well-being in the workforce with the aim to enhance employability in later working life (Federal Ministry for Economic Affairs and Energy, 2016: 37).

The multiple repercussions of an ageing workforce approaching retirement age have gained increasing academic attention over the last two decades and involve many research lines in its investigation (*e.g.* Börsch-Supan *et al.*, 2003; Radl, 2012; Hofäcker, 2015; Hofäcker and Naumann, 2015; Dauth and Toomet, 2016; Klaus *et al.*, 2017; Franke and Simonson, 2018; Hasselhorn and Ebener, 2018). Empirical evidence on the impact of working conditions on later employee health and well-being and – consecutively – employment, is increasing (*e.g.* Dragano and Schneider, 2011; van Aerden *et al.*, 2015; European Foundation for the Improvement of Living and Working Conditions (Eurofound), 2016; Fisher *et al.*, 2016; Knardahl *et al.*, 2017; Bujacz *et al.*, 2018; Ní Léime *et al.*, 2020). In a systematic review of 20 longitudinal, international studies, Scharn *et al.* (2018) identified 21 single work factors that affect retirement timing, suggesting that the work domain may be of substantial importance in the context of EWL research. Furthermore, a systematic review of 20 European studies, published from 1996 to 2010, identified a higher risk for disability retirement associated with psychosocial job demand exposure (Dragano and Schneider, 2011). The associated characteristics in this context were low control, monotonous work tasks, work stress, lack of social support, work organisational and leadership behaviour problems. The adverse impact of low control for disability retirement was especially verified in a recent systematic review and meta-analysis on 39 mainly Scandinavian studies from 2002 to 2014, with over 200,000 employees covering all working ages or higher working-age groups only (Knardahl *et al.*, 2017). The authors also found limited evidence for a higher risk of disability retirement associated with organisational change, lack of employee development, monotonous work task and effort–reward imbalance. To summarise, these findings suggest impaired employability and premature retirement when adverse physical, psychosocial and work organisational work exposures cumulate in later working life. They also highlight the need for the consideration of the entirety of the work environment when aiming to extend working lives. Current EWL policy is considering later retirement as a realistic objective for all employees. However, it has been criticised widely for

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disregarding the need for implementing measures to improve job quality as a precondition for achieving this political goal (Hasselhorn, 2020*a*).

Taylor *et al.* (2016) add the notion that different motivations in the heterogeneous older workforce should also be recognised in research, in order to understand better the complex work–retirement transition. Despite the prevailing EWL agenda and increasing proportions of employees who are about to transition to retirement (Federal Office of Statistics, 2020), the willingness to continue working among them in Germany continues to be low (Hofäcker, 2015), widely follows the social gradient (Hofäcker and Naumann, 2015) and is clearly associated with various work exposures in the direction expected (Hasselhorn, 2020*b*).

When linking the motivation to bring forward or postpone retirement to working conditions, Fisher *et al.* (2016) recommend that research should not limit its focus on single work exposures, but rather take the multiple facets of job quality and their interplay into account. Thus, the central aim of this study is to investigate whether and how the entirety of job quality in the older workforce in Germany changes in the years approaching retirement age, and whether and how these changes impact the motivation to work.

## *Typologies of job quality*

Occupational epidemiology has begun to move from investigating single job quality characteristics to considering a multitude of them simultaneously using finite mixture modelling. In doing so, the scientific focus lies on identifying typical constellations of work exposures that comprehensively capture the work situation of certain groups of employees (Lowe, 2007; Vanroelen *et al.*, 2010; Eurofound, 2016). The EU agency Eurofound identified five job quality profiles with seven established indices by means of latent profile analysis (LPA), using cross-sectional data of roughly 27,000 workers from the 28 EU states covering the full range of working age (Eurofound, 2016). Their least favourable manual profile scored adversely on almost all job characteristics and, consequently, workers assigned to this profile may constitute a potential risk group for impaired health, wellbeing, and early exit from work and employment. In contrast, identification of a most favourable profile was not as clear-cut, as the remaining profiles scored favourable on some characteristics (*e.g.* in the physical domain), but adverse on others. Similar research attempts were already undertaken for Canada (Lowe, 2007) and Belgium (Vanroelen *et al.*, 2010). While such person-centred approaches better portray the heterogeneity of the workforce by taking the exposure perspective of the worker into account, the temporal dimension as an integral feature of working life is not considered adequately (Dannefer, 2003; Baltes *et al.*, 2012; Amick *et al.*, 2016). This, however, is required by lifespan and accumulation theorists who emphasise the dynamic impact that work and employment may have for the individual's constitution over working life (Dannefer, 2003; Baltes *et al.*, 2012). To overcome this limitation, Bujacz *et al.* (2018) empirically identified four latent classes of psychosocial working conditions by means of latent transition analysis among 1,700 Swedish high-skilled workers and investigated class stability over six years. In their study, workers from two classes scoring adversely on the chosen characteristics tended to shift to a less-demanding class regarding

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work intensity, while a class scoring favourably on all characteristics remained stable in size.

Besides a differentiated understanding of the relation between work quality and employment, clustering older employees as outlined above also facilitates the detection of inequalities in the work–retirement transition, because some job quality constellations may systematically disadvantage social groups (Dannefer, 2003). Today, there is growing academic concern that the EWL paradigm bears the risk of exacerbating social inequalities (Hasselhorn, 2020*a*; Ní Léime *et al.*, 2020). For example, after large-scale implementation of EWL measures in Germany, the lower educated tended to work longer for financial reasons (Hofäcker and Naumann, 2015). In another study of 1,300 Swedish retirees, a higher retirement age was associated with worse post-retirement health for the lower but not the higher educated. This was even more pronounced when retiring involuntarily, due to increasing physical demands at work (König *et al.*, 2019). These examples demonstrate systematic accumulation of adversities over the later lifecourse and warrant critical reconsideration of the EWL paradigm in the face of a poor-quality work environment (Dannefer, 2003; Phillipson, 2019). Accordingly, academics argue for improvement of job quality as a precondition for sustainable policies to encourage employment participation in later life with the best possible health (Phillipson, 2019). Current EWL strategies do not differentiate systematically between social groups differently equipped with resources and risks. This raises ethical concerns regarding the long-term consequences of EWL for disadvantaged workers (Hasselhorn, 2020*a*).

Until recently, there were no job quality profiles available for baby-boomer cohorts in Germany. However, different profile distributions between European countries (as found by Eurofound, 2016) suggest different profiles may emerge when specific age groups of the working population are investigated in single countries. This limitation was overcome by a recent study, in which the entirety of the work environment of German baby-boomer cohorts was described with different constellations of nine job quality characteristics (Hasselhorn *et al.*, 2020*b*; *see* Figure 1).

Five profiles were identified by means of LPA for predominantly manual ('Poor Quality' (PQ), 'Relaxed Manual' (RM)) and non-manual workers ('Strained non-Manual' (SnM), 'Smooth Running' (SR), 'High Flying' (HF)), which build the conceptual base for the research questions addressed in the present study. Workers assigned to PQ score adversely on almost all characteristics, while those in RM build upon favourable work intensity and social resources. This difference between both profiles finds expression in the poorest physical and mental health and work ability, and the highest work–privacy conflict for PQ, while those in RM show better mental health and the lowest work–privacy conflict (Hasselhorn *et al.*, 2020*b*). Importantly, the distribution of basic sociodemographic characteristics is quite similar for workers in PQ and RM: both have predominantly low to medium educational levels, as well as task complexity levels, and work frequently in agriculture, production, logistics and safety, and certain services. Workers in SnM experience a complementary job quality constellation to RM, while the constellation in SR may be the most resource-rich for assigned workers. The differences between these profiles are expressed by the poorest mental health and the highest work–privacy conflict for those in SnM, while workers in SR score favourably on

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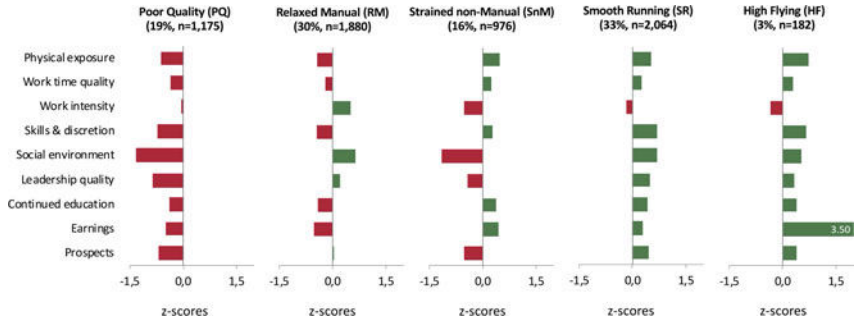



**Figure 1.** Job quality profiles for older workers in Germany.
*Notes*: N = 6,277. Red: adverse manifestation. Green: favourable manifestation. The earnings bar of the HF profile is shortened and the actual *z*-score is displayed.
*Source*: Adapted from Hasselhorn *et al*. (2020*b*).

the above-mentioned outcomes. Workers assigned to SnM and SR similarly display medium to high educational levels and cover the upper range of task complexity levels. Here, natural and information technology sciences, business organisation and administration, the health and social sector, and humanities are the most prevalent occupational areas. Consequently, and with respect to both manual and non-manual profiles, adversity (PQ, SnM) or favourability (RM, SR) of work exposure seems to depend on local working conditions rather than on sociodemographic characteristics. Finally, the very small HF profile is similar to SR but with extremely high earnings, which manifests in the best physical health and work ability (Hasselhorn *et al*., 2020*b*). To summarise, the PQ profile may represent an adverse job quality constellation among manual workers and RM the favourable counterpart. For non-manual workers, SnM reflects the adverse constellation and SR the favourable counterpart (HF may be considered as a special case of SR for ease of tangibility). Together, these five profiles portray specific job quality constellations with different consequences for health, motivation and employability. To date, it is unknown how the work environment of the baby-boomer workforce in Germany – as represented by these job quality profiles – develops in their final working years and what consequences change or stability of the work environment may have for the individual worker.

## Motivations in the retirement process

Employment-related motivations are sparsely researched considering conceptual and methodological issues (Ebener, 2019), even though they are ascribed high relevance for the ageing workforce in retirement research (Wang and Shultz, 2010; Kooij *et al*., 2011; Hasselhorn *et al*., 2015). A recent advancement was made by the conceptual separation of a *motivation to work* (MTW) from a job-specific *motivation at work* and *motivation to retire* (Kanfer *et al*., 2013). While the latter two are assumed to target allocations of effort at work and exit from an existing work arrangement in later working life, respectively, MTW is considered a generic, purposive motivation to enter into a work arrangement and to participate in the

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workforce up to and beyond normative retirement age (Kanfer *et al*., 2013: 256). Regarding MTW as a new hypothetical construct, recent evidence from data representative for employed baby-boomers in Germany supports the assumption of MTW as a unique motivation in later working life (Ebener, 2019).

It is assumed that MTW gains salience in later working life (Kanfer *et al*., 2013) and that it may function as a personal resource in the work–retirement transition (Wang and Shultz, 2010; Kanfer *et al*., 2013). This allows the integration of the construct of motivation into broader concepts that focus on the investigation, understanding and prediction of outcomes of the retirement process. One such concept is the lidA framework on work, age, health and employment participation, where MTW (besides work ability) functions as an immediate determinant that mediates the association of retirement with antecedents from the work and private domains, health and (partly) finances (Hasselhorn and Ebener, 2018). Here, retirement is considered a process reflecting decades of work exposure affecting an individuals' MTW and their pathway towards (quality and timing of) retirement. Thus, specifically among workers approaching retirement age, the accumulated effect of job quality should be reflected by their MTW.

However, most research questions in this field are investigated in cross-section. One such study with approximately 230 German employees aged 54–62 showed that job demands were negatively related, and job resources positively related to MTW – with both effects being mediated through differences in the perception of work as coherent and concurrent health (Lichtenthaler and Fischbach, 2016). Conceptually similar results were found in the Netherlands for care workers aged 40–63 (Polat *et al*., 2017). In an exploratory cross-sectional study on nearly 2,000 older employees aged 55–74 in the Swedish health-care sector, Nilsson (2017) investigated three groups of employees: those who would like to and think they are able to work beyond 65 years, those stating they are able to but do not want to, and those negating in both instances (a corresponding fourth group was too small for analyses). Here, work environmental factors were consistently associated with the ability to work beyond retirement age and work motivational factors in turn discriminated most, regarding the desired retirement age. This suggests that different working conditions may affect representations of retirement on different levels (Nilsson, 2017).

Such studies yield important evidence on the association of working conditions and MTW in general, yet neglect the temporal dimension and, thus, accumulated exposure effects (*cf*. Lowe, 2007; Vanroelen *et al*., 2010; Fisher *et al*., 2016; Hasselhorn *et al*., 2020*b*), a perspective that might be advised in research on the work–retirement transition (Baltes *et al*., 2012; Amick *et al*., 2016). Of the few studies that investigated this association longitudinally, Frins *et al*. (2016) found in a representative Dutch sample of 2,900 workers aged 50–64 that after a one-year follow-up, those with high job resources wanted to retire later, whereas this was reversed for those with high demands. Further, they found evidence for the presence of motivational gain and loss cycles, where availability of job resources enabled accumulation of more resources. Whereas high demands prevented effective coping, thus resulting in accumulation of more demands. Conceptually similar results were found by Schreurs *et al*. (2011) for Belgian workers aged 45+.

Despite this evidence for accumulation effects of adverse or favourable job quality on MTW, it remains open whether a change of working conditions is associated

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with differences in MTW (de Wind *et al.*, 2016, 2017; Fisher *et al.*, 2016). Previous findings suggest that adverse or favourable working conditions may deplete or enhance MTW in the years approaching retirement age (Schreurs *et al.*, 2011; Frins *et al.*, 2016; Lichtenthaler and Fischbach, 2016; Nilsson, 2017; Polat *et al.*, 2017). Moreover, they imply that – over the course of time – a reversal of exposure accumulation may allow workers to recover from a demanding work environment, thus enhancing MTW, particularly when a work environment improves quite early. Concurrently, a deteriorating work environment may deplete a worker's resources, thus impairing MTW. This effect may be more pronounced when a work environment deteriorates at an earlier point in time.

### *Lack of research and study purpose*

To the authors' knowledge, there is no study investigating the entirety of job quality, as well as its accumulated effects on MTW, in a representative sample of the older workforce in Germany. Yet, when it comes to EWL, monitoring groups of workers to whom certain job quality constellations apply at a given point of time in working life and linking those trajectories to a specific motivation salient to them in this context, both may allow estimation of the accumulated work exposure effects for premature or delayed retirement (Wang and Shultz, 2010; Hofäcker and Naumann, 2015; Ebener, 2019). Such knowledge could also help enterprises and policy makers to adjust measures directed at raising employment participation (Federal Ministry for Economic Affairs and Energy, 2016; Taylor *et al.*, 2016), while considering disadvantaged workers concomitantly (Hofäcker and Naumann, 2015; Bujacz *et al.*, 2018; König *et al.*, 2019; Hasselhorn, 2020*a*; Ní Léime *et al.*, 2020) and thereby increasing efficiency and fairness of EWL strategies.

To summarise, the research aim of the present study is twofold. First, structural stability of job quality profiles will be addressed by exploring whether and how their prevalence changes within a representative sample of workers in the German baby-boomer generation. In addition, individual profile stability will be explored by focusing on the qualitative direction that workers transfer between profiles over time. Second, workers with selected trajectories regarding timing and qualitative direction of job quality change will be examined with regard to differences in MTW at the end of the assessment period. In this context, it is hypothesised for both manual as well as non-manual workers that:

- Hypothesis 1 (H1): those with constant favourable job quality exhibit the highest and the adverse counterpart the lowest MTW levels.
- Hypothesis 2 (H2): an early change from adverse to favourable job quality is associated with higher MTW levels compared to constant adverse job quality.
- Hypothesis 3 (H3): an early change from favourable to adverse job quality is associated with lower MTW levels compared to constant favourable job quality.
- Hypothesis 4 (H4): a later change from adverse to favourable job quality is associated with lower MTW levels compared to an early change.
- Hypothesis 5 (H5): a later change from favourable to adverse job quality is associated with higher MTW levels compared to an early change.

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## Methods

### Study design and sampling

We used data from the German 'leben in der Arbeit' (lidA; German for 'living at work') study on work, age, health and employment participation (www.lida-studie.de). lidA is a prospective cohort study focusing on the transition from work to retirement in two German baby-boomer cohorts born in 1959 or 1965 (Hasselhorn *et al.*, 2014). Participants were randomly drawn in a two-stage sampling procedure and surveyed via computer-assisted personal interviews at their homes in 2011 (N = 6,585), 2014 (N = 4,244) and 2018 (N = 3,586). A cut-off of 50+ years is used in many studies to define older workers, others already take 45 + years or 55+ years only (*see e.g.* Farrow and Reynolds, 2012: 5). According to the German Federal Employment Agency, workers aged 45+ already have a lowered employability (Dauth and Toomet, 2016). Thus, regarding the German labour market, both cohorts of the lidA study are considered relevant in this context to represent the older part of the German workforce. In 2011, the response rate (RR5) was 27.3 per cent and the co-operation rate (COOP3) was 32.6 per cent (according to the American Association for Public Opinion Research, 2016), which is similar to that of other German studies of comparable design (*e.g.* Klaus *et al.*, 2017). In all three instances, the samples are representative for the socially insured working population (no self-employed or sworn civil servants) of the respective age cohort as of 31st December 2009, where initial sampling was planned. However, the younger cohort was deliberately oversampled to compensate for future loss to follow-up (Table 1; Schröder *et al.*, 2013; Steinwede *et al.*, 2015, 2018). A detailed study design and cohort profile is found in Hasselhorn *et al.* (2014). As shown in Table 1, there were minor differences between the cohort´s distribution of educational level and self-rated health across assessments.

Participants were included in the final sample if they were subject to social insurance contributions and employed for at least one hour per week in each assessment. To first investigate profile development over time, participants for whom valid profile data (*see* below) were available for all three assessments were selected (N = 2,863; *cf.* Table 1). In each cohort of this final complete-case sample, the distribution of sex, educational level, weekly working hours and self-rated health did not differ significantly from that of the total 2018 sample.[1] For the second part of the analyses, a sub-sample of these N = 2,863 was drawn which was comprised of workers with specific manual and non-manual job quality trajectories that correspond to the study hypotheses. Hence, for the second analyses part the sample size reduced to N = 1,582, which represents 55.2 per cent of the complete-case study sample.

### Measures

#### Job quality trajectories

This article builds on earlier research based on lidA data from 2011 in which the above-described job quality profiles were empirically identified by means of LPA (Hasselhorn *et al.*, 2020*b*). These profiles intend to capture qualitative different work environments of the older German workforce by means of distinct constellations of the following nine job quality characteristics: physical exposure, work time

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**Table 1.** Sociodemographic characteristics (valid %) for the samples per assessment years and for the final study sample by cohort

| | 2011 (N = 6,585) | | | | 2014 (N = 4,244) | | | | 2018 (N = 3,586) | | | | Study sample (N = 2,863) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cohort 1959 | | Cohort 1965 | | Cohort 1959 | | Cohort 1965 | | Cohort 1959 | | Cohort 1965 | | Cohort 1959 | | Cohort 1965 | |
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| Sex: | | | | | | | | | | | | | | | | |
| Male | 1,333 | 45.8 | 1,730 | 47.0 | 841 | 43.8 | 1,074 | 46.3 | 709 | 43.7 | 901 | 46.1 | 574 | 44.5 | 721 | 46.0 |
| Female | 1,575 | 54.2 | 1,947 | 53.0 | 1,081 | 56.2 | 1,248 | 53.7 | 915 | 56.3 | 1,055 | 53.9 | 717 | 55.5 | 848 | 54.0 |
| Educational level: | | | | | | | | | | | | | | | | |
| Low | 843 | 29.3 | 866 | 23.7 | 482 | 25.3 | 470 | 20.3 | 384 | 23.9 | 393 | 20.2 | 297 | 23.1 | 280 | 17.9 |
| Medium | 1,473 | 51.2 | 2,026 | 55.5 | 1,016 | 53.4 | 1,342 | 58.1 | 872 | 54.2 | 1,129 | 58.0 | 690 | 53.8 | 921 | 59.0 |
| High | 562 | 19.5 | 757 | 20.7 | 406 | 21.3 | 498 | 21.6 | 354 | 22.0 | 424 | 21.8 | 296 | 23.1 | 361 | 23.1 |
| Weekly working hours: | | | | | | | | | | | | | | | | |
| ⩽19 | 263 | 9.7 | 381 | 10.9 | 174 | 9.9 | 206 | 9.7 | 152 | 10.8 | 150 | 8.5 | 121 | 9.9 | 114 | 7.6 |
| 20–34 | 577 | 21.2 | 695 | 20.0 | 364 | 20.8 | 428 | 20.2 | 349 | 24.9 | 445 | 25.3 | 305 | 24.9 | 374 | 25.1 |
| ⩾35 | 1,884 | 69.2 | 2,407 | 69.1 | 1,211 | 69.2 | 1,490 | 79.2 | 903 | 64.3 | 1,161 | 66.1 | 798 | 65.2 | 1,005 | 67.3 |
| Self-rated health status:[1] | | | | | | | | | | | | | | | | |
| Poor | 1,384 | 49.7 | 1,493 | 42.0 | 961 | 52.6 | 980 | 44.3 | 785 | 53.0 | 884 | 47.7 | 677 | 53.1 | 733 | 46.9 |
| Good | 1,401 | 50.3 | 2,060 | 58.0 | 865 | 47.4 | 1,234 | 55.7 | 696 | 47.0 | 970 | 52.3 | 598 | 46.9 | 830 | 53.1 |

*Notes*: Frequencies not adding up to the respective total sample size are due to missing values. 1. Dichotomised as poor = very poor/poor/satisfactory, good = good/very good.

quality, work intensity, skills and discretion, social environment, leadership quality, continued education, earnings and prospects. Apart from both the continued education and the earnings index, the remaining seven indices are the composite of several single items and/or established scales following the index construction approach of Eurofound (2016).[2] The final five-profile solution demonstrated relative structural stability in the initial LPA. Validity of the five profiles was given through diverging patterns of association over time with physical and mental health, work–privacy conflict and work ability, thus representing distinct subgroups of the older working population. For the present study, participants were assigned a profile in the 2014 and 2018 assessment per highest posterior probability estimated with the equation of the initial latent profile model from the 2011 assessment (computed with LatentGOLD 5.1®). Mean posterior probabilities per profile in 2011/2014/2018 indicated reliable classification and were as follows: for PQ they were 0.86/0.85/0.82, for RM 0.84/0.83/0.83, for SnM 0.84/0.85/0.89, for SR 0.85/0.85/0.88 and for HF 0.94/0.96/0.98. Next, the small HF profile was merged with the conceptually similar SR profile for appropriate group sizes in subsequent analyses and to facilitate interpretability (all done in IBM SPSS Statistics 25®). Missing values inspection on the profile indices yielded proportions below 1.0 per cent in most instances with missings on three indices ranging from 1.4 to 4.7 per cent in single assessments. Corresponding to the mean refusal rate in Europe for disclosing earnings (Eurofound, 2016), the proportions of missing values for earnings were albeit higher (19.9% in 2011, 15.9% in 2014 and 18.2% in 2018) and were replaced by means of stochastic regression imputation (Enders, 2010). Sensitivity analyses showed that loss to follow-up and unemployment occurred to a small degree, with slightly higher proportions in the manual profiles in both instances.

Job quality trajectories were coded depending on the respective profile assignment per assessment, resulting in a total of $4 \times 4 \times 4 = 64$ trajectories. Due to initial oversampling, the group size of the younger cohort was slightly larger. As this was the case for all trajectories, it was decided consequently to analyse both cohorts jointly. To address the study hypotheses specifically, 12 of these 64 trajectories were selected to allow for plausible group comparisons, while the remaining 52 trajectories were discarded. Constant assignment of predominantly manual workers to adverse job quality in 2011, 2014 and 2018 is depicted by the PQ–PQ–PQ trajectory group and by RM–RM–RM for constant favourable job quality. An early change (between 2011 and 2014) from favourable to adverse job quality is depicted by the RM–PQ–PQ trajectory group and a later change (between 2014 and 2018) from adverse to favourable by the PQ–PQ–RM trajectory group, respectively. This was done by analogy for predominantly non-manual workers (SnM, SR). All trajectories are displayed in Tables 3 and 4.

### *Occupational change*

Occupational change was assessed in 2014 and 2018 and is included as ancillary variables to determine the nature of profile change before further investigating MTW differences between the selected trajectories (*cf.* Table 3). Participants were asked to indicate whether they (a) had changed their employer since the last interview (yes/no) and (b) whether their profession had remained the same since the last interview (yes/no).

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### *Motivation to work*

The outcome measure developed initially for the 2018 assessment was the 'motivation to work' scale (MTW; Ebener and Stiller, 2019). It intends to capture key aspects of MTW via self-report on a five-point rating scale ranging from 1 = 'does not apply at all' to 5 = 'fully applies'. The respective items are (translated from German): 'I consider it highly probable that I am going to work until statutory retirement age', 'The earlier I can quit working the better' (reverse-coded), 'I would like to work beyond statutory retirement age', 'I cannot even imagine that I am ever going to stop working' and 'I feel I am going to miss my work when I think about retirement' ($\omega = 0.75$). Confirmatory factor analyses supported a one-factorial congeneric model, with metric invariance holding across sexes. Considering the different statutory retirement ages applying to each cohort (1959 cohort: 66.2 years; 1965 cohort: 67.0 years), attention was paid to construct a content-free scale, *i.e.* without items mentioning specific retirement ages or conditions like health/finances, to prevent response bias resulting from the difference in remaining working years. Consequently, the 1959 (mean = 2.33, standard deviation (SD) = 0.98) and the 1965 cohort (mean = 2.38, SD = 0.89) did not differ significantly in mean MTW levels, $t(3213) = -1.5$, $p = 0.145$. Further, MTW scores have high correlatation with desired and planned retirement age (Pearson $r = 0.58$ and $r = 0.52$) and low correlatation with intrinsic work motivation (Pearson $r = 0.20$) and self-rated health (Spearman rho = 0.17), suggesting a construct-wise valid interpretation of MTW scores (Ebener and Stiller, 2019). A mean value was computed for each participant with higher values representing higher MTW levels.

To verify profile adversity and favourability in the final study sample (N = 2,863), mean MTW differences in 2018 were tested with an analysis of variance (ANOVA) between job quality profiles prior to the final analyses. A main effect was found for profile assignment in 2018, $F(3, 2{,}859) = 13.9$, $p < 0.001$, $\eta^2 = 0.02$. Workers in RM or SR displayed higher MTW levels compared to those in PQ and SnM, respectively (both $p < 0.001$). A comparison between RM and SR as well as between PQ and SnM did not indicate significant differences though (both $p = 1.0$), suggesting that RM and SR represent favourable and PQ and SnM represent adverse job quality profiles regarding MTW (for mean values, *see* Table 4). To further rule out the possibility of bias attributable to the selection of specific trajectories as outlined above, mean MTW scores of the selected participants with manual (mean = 2.36, SD = 0.93; N = 491) and non-manual trajectories (mean = 2.37, SD = 0.94; N = 1,091) were tested against those excluded from later MTW analyses (mean = 2.33, SD = 0.90; N = 1,281). However, there was no main effect regarding mean differences between those groups, $F(2, 2{,}860) = 0.6$, $p = 0.551$, suggesting absence of selection bias.

## *Statistical analyses*

Structural changes between profiles over time were explored comparing profile proportions between assessments descriptively and with one-dimensional $\chi^2$-tests. The association between profile assignment and assessment year was tested with a three-way log-linear analysis. Odds ratios (OR) were calculated to assess the degree of association for a certain profile assignment (reference: assignment to any other profile). Hypothesised mean differences on MTW scores were tested between the

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selected trajectory groups with planned non-orthogonal contrasts (one-tailed), applying a Bonferroni–Holm correction to an α-level of 0.05 (Bortz and Schuster, 2010: 232). Effect sizes with Hedges $g \geqslant 0.20$ were classified as small, $g \geqslant 0.50$ as medium and $g \geqslant 0.80$ as large (Cohen, 1988).

## Results

### *Structural and individual profile stability*

First, profile development was explored across assessments. As depicted on the left side of Table 2 (and graphically in Figure 2), the two predominantly manual profiles, PQ and RM, decreased in size from 2011 until 2018, while the non-manual profiles, SnM and SR, increased, $\chi^2(3) = 284.5$, $p < 0.001$. This trend was apparent for PQ and SnM in the first observation period already, $\chi^2(3) = 8.7$, $p = 0.034$, but even more so for all four profiles in the second assessment period, $\chi^2(3) = 218.3$, $p < 0.001$, indicating that over time older employees shifted to less physically demanding profiles, especially when former job quality was adverse.

Next, the log-linear analysis produced a final model that retained all two-way interactions, $\chi^2(27) = 32.7$, $p = 0.206$ (right column in Table 2). For the 2011 × 2014 interaction ($\chi^2(9) = 684.5$, $p < 0.001$), the highest OR in 2014 were obtained for profile continuity: *e.g.* for all 474 workers assigned to PQ in 2011, OR to remain there in 2014 were 7.4. The respective OR for RM were 6.2, for SnM 4.6 and for SR 7.5. The OR for PQ to switch to RM were 1.4 and 1.1 and *vice versa*, indicating a somewhat higher association between manual profiles.

Regarding the significant 2014 × 2018 interaction ($\chi^2(9) = 479.1$, $p < 0.001$), the assignment pattern for the manual profiles reported above was even more pronounced. Among the non-manual profiles, profile continuity dropped for SnM from OR = 4.6 to 3.6 and for SR from OR = 7.5 to 5.8. This, however, may be attributed to the increasing total size of the non-manual profiles to which manual workers had shifted in the meantime. A detailed report of the significant 2011 × 2018 interaction ($\chi^2(9) = 231.7$, $p < 0.001$) is omitted as the OR largely resemble those of the 2014 × 2018 interaction. To summarise, these patterns indicate a certain degree of profile continuity, yet profile changes are apparent for large shares of the sample, especially within the manual and non-manual profiles, respectively (*see* Figure 2).

Regarding individual profile stability, 3.0 per cent of the sample stayed in PQ across all three assessments. The proportions were 7.2 per cent for those constantly in RM, 3.6 per cent for SnM and 21.3 per cent for SR, adding up to a constant seven-year job quality for 35.1 per cent of all participants studied. Hence, nearly two-thirds of the sample experienced varying degrees of job quality change over time (*cf.* Figure 2).

### *Occupational and profile change*

Before the second analyses, we inspected whether a profile change was preceded by a change of employer or profession in the trajectories selected for MTW analyses (N = 1,582), as such an association might obscure the hypothesised job quality effects on MTW. As documented in Table 3, occupational change was rarely

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**Table 2.** Profile size and percentage assignment with odds ratios for job quality profiles by assessment year

| | | PQ | | RM | | SnM | | SR | |
|---|---|---|---|---|---|---|---|---|---|
| | N (% of 2,863) | % | OR | % | OR | % | OR | % | OR |
| 2011 assignment: | | 2014 assignment | | | | | | | |
| PQ | 474 (16.6) | 42.8 | 7.4 | 33.1 | 1.4 | 15.0 | 0.8 | 9.1 | 0.1 |
| RM | 779 (27.2) | 15.3 | 1.1 | 55.2 | 6.2 | 7.4 | 0.2 | 21.1 | 0.3 |
| SnM | 477 (16.7) | 13.0 | 0.8 | 11.1 | 0.3 | 41.4 | 4.6 | 34.4 | 0.8 |
| SR | 1,133 (39.6) | 3.5 | 0.1 | 12.0 | 0.2 | 16.7 | 0.9 | 67.8 | 7.5 |
| % of 2,863 in 2014 | | 14.8 | | 27.1 | | 18.0 | | 40.1 | |
| 2014 assignment: | | 2018 assignment | | | | | | | |
| PQ | 424 (14.8) | 34.9 | 7.8 | 21.9 | 1.4 | 24.8 | 1.1 | 14.8 | 0.2 |
| RM | 776 (27.1) | 14.2 | 1.6 | 40.5 | 6.6 | 13.3 | 0.3 | 32.1 | 0.4 |
| SnM | 516 (18.0) | 5.0 | 0.4 | 6.4 | 0.3 | 45.9 | 3.8 | 42.6 | 0.8 |
| SR | 1,047 (40.1) | 1.8 | 0.1 | 5.9 | 0.2 | 19.3 | 0.7 | 73.0 | 5.8 |
| % of 2,863 in 2018 | | 10.7 | | 17.7 | | 23.3 | | 48.3 | |

*Notes*: N = 2,863. OR: odds ratio for respective profile assignment (reference: assignment to any other profile in the respective assessment). PQ: Poor Quality. RM: Relaxed Manual. SnM: Strained non-Manual. SR: Smooth Running.

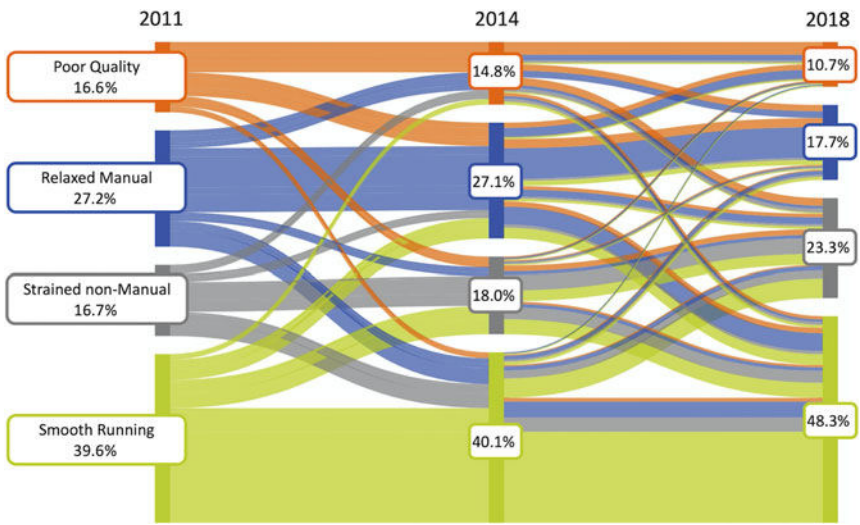



**Figure 2.** Job quality profiles for older employees in Germany across seven years
*Notes*: N = 2,863. Trajectories with N < 4 cannot be displayed for reasons of data protection.

observed. On average, change of employer (8.2%) and profession (6.9%) were less frequent between 2011 and 2014 than between 2014 and 2018 (11.1 and 9.5%, respectively). Beyond that, occupational change occurred somewhat more frequent

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**Table 3.** Proportion of workers (% of N) per trajectory group with change of employer or profession in each follow-up period

| | Change between 2011 and 2014 | | | | Change between 2014 and 2018 | | | |
|---|---|---|---|---|---|---|---|---|
| | Employer | | Profession | | Employer | | Profession | |
| Trajectory | N | % of N | N | % of N | N | % of N | N | % of N |
| Manual: | | | | | | | | |
| PQ–PQ–PQ | 86 | 7.0 | 85 | 3.5 | 86 | 8.1 | 85 | 2.4 |
| RM–RM–PQ | 58 | 10.3 | 57 | 5.3 | 58 | 10.3 | 57 | 7.0 |
| RM–PQ–PQ | 38 | 13.2 | 38 | 7.9 | 38 | 13.2 | 38 | 10.5 |
| RM–RM–RM | 205 | 14.6 | 206 | 8.3 | 205 | 16.6 | 205 | 12.2 |
| PQ–PQ–RM | 43 | 11.6 | 43 | 7.0 | 42 | 26.2 | 43 | 23.3 |
| PQ–RM–RM | 61 | 19.7 | 61 | 11.5 | 60 | 26.7 | 60 | 23.3 |
| Non-manual: | | | | | | | | |
| SnM–SnM–SnM | 104 | 4.8 | 103 | 7.8 | 103 | 4.9 | 104 | 7.7 |
| SR–SR–SnM | 125 | 5.6 | 130 | 6.2 | 125 | 5.6 | 130 | 8.5 |
| SR–SnM–SnM | 71 | 0.0 | 71 | 1.4 | 71 | 5.6 | 72 | 4.2 |
| SR–SR–SR | 587 | 6.3 | 607 | 6.6 | 582 | 8.4 | 596 | 8.7 |
| SnM–SnM–SR | 80 | 7.5 | 79 | 3.8 | 78 | 20.5 | 79 | 6.3 |
| SnM–SR–SR | 92 | 8.7 | 96 | 13.5 | 88 | 12.5 | 94 | 11.7 |

*Notes*: N=1,582. Differences in total sample size are due to missing values per occupational change variable and assessment year. PQ: Poor Quality. RM: Relaxed Manual. SnM: Strained non-Manual. SR: Smooth Running. PQ–PQ–PQ, *etc*.: trajectory group (as per 2011, 2014 and 2018 profile assignment).

among the manual job quality trajectories, especially among those with constant or changing to favourable job quality. For single trajectories, where timing of profile change and a higher proportion of occupational change co-occurred during the second follow-up period (PQ–PQ–RM and SnM–SnM–SR), a reversed pattern was not observable in the first follow-up period (PQ–RM–RM and SnM–SR–SR). To summarise, no clear systematics can be observed that reveal occupational change as a determinant of job quality profile change among the selected manuals and non-manuals, respectively.

### *Trajectory effects on MTW*

In the final MTW analyses testing the study hypotheses, a significant Levene's test indicated heteroscedasticity, $F(11,\ 1{,}570) = 3.7$, $p < 0.001$, and as the groups also differed in size (*cf*. Table 4), a robust Welch ANOVA was conducted accordingly. There was a significant main effect for trajectory groups on MTW, Welch's $F(11,\ 334.23) = 5.6$, $p < 0.001$, $\eta^2 = 0.03$.

As hypothesised in H1, manual employees with constant favourable job quality (RM–RM–RM) exhibited higher MTW levels than the adverse counterpart

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**Table 4.** Descriptive statistics for motivation to work scores by 2018 profile assignment and selected trajectory group

| | | | 2018 assignment | | Selected trajectory | |
|---|---|---|---|---|---|---|
| Profile | N | % of N | Mean | SD | Mean | SD |
| PQ | 305 | 10.7 | 2.15 | 0.92 | – | – |
| RM | 508 | 17.7 | 2.46 | 0.93 | – | – |
| SnM | 666 | 23.3 | 2.20 | 0.86 | – | – |
| SR | 1,384 | 48.3 | 2.43 | 0.94 | – | – |
| Manual: | | | | | | |
| PQ–PQ–PQ | 86 | 3.0 | – | – | 2.04 | 0.80 |
| RM–RM–PQ | 58 | 2.0 | – | – | 2.23 | 0.95 |
| RM–PQ–PQ | 38 | 1.3 | – | – | 2.37 | 0.93 |
| RM–RM–RM | 206 | 7.2 | – | – | 2.55 | 0.97 |
| PQ–PQ–RM | 42 | 1.5 | – | – | 2.06 | 0.72 |
| PQ–RM–RM | 61 | 2.1 | – | – | 2.51 | 0.90 |
| Non-manual: | | | | | | |
| SnM–SnM–SnM | 104 | 3.6 | – | – | 2.22 | 0.87 |
| SR–SR–SnM | 130 | 4.5 | – | – | 2.12 | 0.74 |
| SR–SnM–SnM | 72 | 2.5 | – | – | 2.16 | 0.83 |
| SR–SR–SR | 609 | 21.3 | – | – | 2.46 | 0.97 |
| SnM–SnM–SR | 80 | 2.8 | – | – | 2.22 | 0.83 |
| SnM–SR–SR | 96 | 3.4 | – | – | 2.55 | 1.10 |

*Notes*: N = 2,863 (workers with selected trajectories (N = 1,582) correspond to 55.2% of N = 2,863). SD: standard deviation. PQ: Poor Quality. RM: Relaxed Manual. SnM: Strained non-Manual. SR: Smooth Running. PQ–PQ–PQ, *etc.*: trajectory group (as per 2011, 2014 and 2018 profile assignment).

(PQ–PQ–PQ), $t(192) = 4.7$, $p < 0.001$, $g = 0.55$, 95% confidence interval (CI) = 0.30; 0.81 (*see* Table 4). An early change from adverse to favourable (PQ–RM–RM) enhanced MTW compared to those with constant adverse job quality (PQ–PQ–PQ), thus confirming H2, $t(119) = 3.2$, $p = 0.001$, $g = 0.56$, 95% CI = 0.22; 0.89. Contrary to the prediction in H3, the reversed effect (RM–PQ–PQ compared to RM–RM–RM) was not significant, $t(53) = 1.1$, $p = 0.139$. A later change from adverse to favourable (PQ–PQ–RM) resulted in lower MTW levels than those changing earlier (PQ–RM–RM), confirming H4, $t(99) = 2.8$, $p = 0.004$, $g = 0.54$, 95% CI = 0.14; 0.94. In contrast to the prediction in H5, there was no significant MTW difference between those with a later change from favourable to adverse (RM–RM–PQ) compared to those changing earlier (RM–PQ–PQ), $t(81) = 0.8$, $p = 0.227$ (*cf.* Figure 3).

A comparable pattern emerged for the non-manual trajectory groups (*cf.* Table 4). As predicted in H1, constant favourable job quality (SR–SR–SR) resulted in higher MTW levels than in the adverse counterpart (SnM–SnM–SnM),

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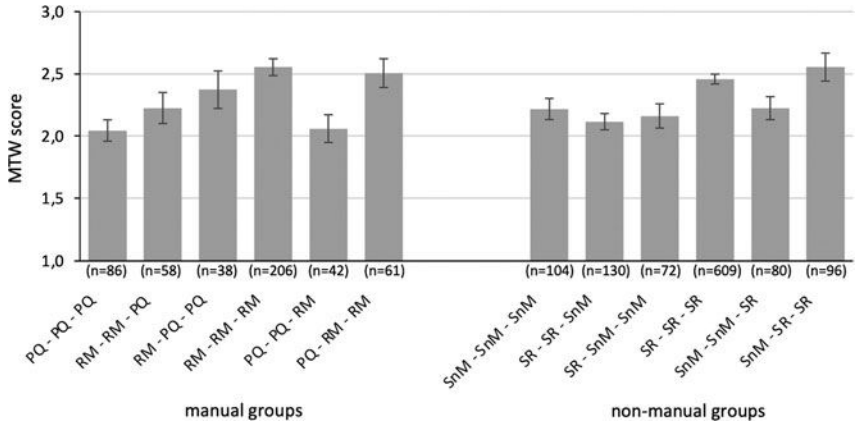



**Figure 3.** Mean motivation to work (MTW) scores (with standard errors) in 2018 for trajectory groups. *Notes*: PQ: Poor Quality. RM: Relaxed Manual. SnM: Strained non-Manual. SR: Smooth Running. PQ–PQ–PQ, *etc*.: trajectory group (as per 2011, 2014 and 2018 profile assignment).

$t(150) = 2.6$, $p = 0.006$, $g = 0.25$, 95% CI = 0.04; 0.46. An early change to the favourable profile (SnM–SR–SR) enhanced MTW compared to constant adverse job quality (SnM–SnM–SnM), confirming H2, $t(180) = 2.4$, $p = 0.009$, $g = 0.33$, 95% CI = 0.06; 0.61. The reversed pathway (SR–SnM–SnM compared to SR–SR–SR) yielded significantly lower MTW levels, $t(96) = 2.8$, $p = 0.003$, $g = 0.31$, 95% CI = 0.07; 0.56. Thus, H3 is confirmed. In line with H4, a later change from adverse to favourable (SnM–SnM–SR) resulted in lower MTW levels compared to those changing earlier in a similar direction (SnM–SR–SR), $t(172) = 2.3$, $p = 0.013$, $g = 0.33$, 95% CI = 0.04; 0.63. In contrast to the prediction in H5, a later change from favourable to adverse (SR–SR–SnM) did not reveal significantly different MTW levels from early changers in the same direction (SR–SnM–SnM), $t(134) = 0.4$, $p = 0.349$ (*cf*. Figure 3).

## Discussion

This study revealed size and direction of job quality change among employed baby-boomers in Germany in the years prior to retirement. First, a general move towards physically less-demanding job quality profiles was observed over time. Profile continuity was evident between assessments in all instances, yet the majority experienced some degree of job quality change across the seven-year observation period. Second, and as expected, those with constant favourable job quality exhibited the highest MTW levels and their respective adverse counterparts exhibited the lowest. Early changes rather than later changes between job quality profiles were associated with the expected MTW levels.

### *Frequency and direction of profile change*

Changes in the work environment seem to occur frequently among German baby-boomer cohorts. The move from manual to predominantly non-manual profiles found in our study is in line with previous findings by Bujacz *et al*. (2018)

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who – over six years – found that workers in profiles characterised by high workload and time pressure moved to profiles with lower levels of demands. However, the study by Bujacz *et al.* (2018) was restricted to psychosocial working conditions among high-skilled workers, whereas the conceptual approach applied in the present study allows for a more nuanced picture. The general move to both non-manual profiles is associated with slightly higher work intensity, but also with less physical exposure, better working time quality, better psychosocial resources, continued education and higher earnings as compared to both manual profiles. These qualitative changes might reflect ageing-related adjustments to decreasing physical resources (König *et al.*, 2019) and family obligations that gain individual importance in the last working years (Baltes *et al.*, 2012; Amick *et al.*, 2016). It remains open as to what determines a switch from one job quality profile to the other among manuals and non-manuals, respectively. As was shown for the 12 selected trajectories, change of employer or profession rarely occurred and were not associated systematically with a change in job quality profile. They may – at the most – explain MTW differences between the trajectories only to a small extent. Other forms of occupational change, such as changes in work tasks (Wong and Tetrick, 2017; Garthe and Hasselhorn, in press), may alter a worker's job quality characteristics. They may occur voluntarily, when initiated by the employee, or involuntarily, *e.g.* when imposed by the organisation (Garthe and Hasselhorn, in press). They may be further associated with cascading effects, when leadership quality changes due to a new supervisor, which in turn might lead to secondary changes in other job quality characteristics (Wong and Tetrick, 2017). For several reasons, the desire for occupational change often remains unfulfilled for large proportions of workers in the years preceding retirement (Garthe and Hasselhorn, in press). This could provide another possible explanation why quality of work continues to be low for some groups of employees. Such potential mechanisms cannot be identified within the current study. Yet, they require thorough investigation in future research to enhance the understanding of dynamics in job quality in later working life.

### *MTW differences between trajectory groups*

Constant job quality was associated with MTW in the expected direction, indicating the presence of accumulating effects of adverse and favourable work exposure on MTW (as assumed in H1). Moreover, changes in job quality seem to be of relevance for MTW in later working life, as the qualitative direction and timing of change were significantly associated with different MTW levels in most instances. Higher MTW levels among those whose trajectory changed between 2011 and 2014 to favourable exposure (as assumed in H2) may represent a form of motivational enhancement resulting from sufficient compensation for prior adverse job quality. On the other hand, and in line with H4, a change between 2014 and 2018 to favourable exposure resulted in lower MTW levels compared to those changing earlier, suggesting that compensatory effects for prior adverse job quality require at least four years of favourable work exposure to enhance MTW substantially. In partial agreement with H3, a change between 2011 and 2014 from favourable to adverse profiles resulted in lower MTW levels, yet this was found for non-manual workers

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only. This might possibly be explained by the relatively low earnings in both manual groups (*cf.* Figure 1). In contrast to non-manual workers, manuals may well depend on working longer for financial objectives (Hofäcker and Naumann, 2015), regardless of their physical condition and the adversities they may be exposed to at work (Hasselhorn *et al.*, 2020*a*). Moreover, manual workers might potentially react with a longer time lag to adverse job quality changes regarding their MTW. In either case, further monitoring is required, as the observation period might have been too short to detect the hypothesised effects for the manual trajectory groups, but also to identify preconditions that differentially predict MTW levels of manual and non-manual trajectory groups in addition to prior job quality changes. Finally, and contrary to H5, a change between 2014 and 2018 from favourable to adverse profiles did not result in higher MTW levels than a change between 2011 and 2014. As discussed for early changes of manuals (in H3), older age groups of the working population may not react as immediately to adverse job quality changes as expected. In addition, these changes might also conflict with other motives and attitudes of the ageing worker, thus preventing alternation of MTW as expected (Kooij *et al.*, 2011; Baltes *et al.*, 2012; Radl, 2012; Wong and Tetrick, 2017; Franke and Simonson, 2018). This opens up a new line of research as it is unclear at the moment whether the observation period was too short and/or whether the manual trajectory groups display a different reaction pattern to adverse job quality changes in general.

The obtained effect sizes for MTW differences were small for non-manual and medium for the manual trajectory groups, suggesting that job quality may play a greater role for work motivational objectives among the latter. Considering our findings, it may be surprising to find EWL policies to be unconnected to work quality. The findings indicate that EWL measures directed at enhancing job quality early may be particularly relevant for workers in manual jobs, where accumulated adverse work exposures (as represented by the PQ profile) have the greatest potential for putting health and well-being at risk (Bujacz *et al.*, 2018; König *et al.*, 2019; Hasselhorn, 2020*a*; Hasselhorn *et al.*, 2020*b*; Ní Léime *et al.*, 2020). Current 'one-size-fits-all' EWL policies (Phillipson, 2019; Ní Léime *et al.*, 2020) not accounting for such working-life exposures are at risk of systematically exacerbating social inequalities, with serious long-term consequences for those confronted with the pressure to continue working (König *et al.*, 2019), regardless of their resources to accommodate these labour market demands (Hasselhorn, 2020*a*; Ní Léime *et al.*, 2020).

This is the first study to investigate stability of the entirety of job quality in a representative sample of workers in a single country and, furthermore, to establish a direct link to their MTW. In doing so, the conceptual approach of Eurofound (*cf.* Eurofound, 2016) has been expanded to longitudinal data which made detecting changes beyond psychosocial working conditions in a specific sample possible (*cf.* Bujacz *et al.*, 2018). The pattern of MTW differences – as found for manual and non-manual trajectory groups – underscores the accumulated impact of job quality as a precursor of MTW. In the broader context of the work–retirement transition, the investigated job quality trajectories may have the potential to affect retirement indirectly, as differences in MTW may be associated with employment in the last working years (Hasselhorn and Ebener, 2018).

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## Strengths and limitations

A major strength of the present study is the simultaneous investigation of changes in the entirety of working conditions (as in Eurofound, 2016), which allows for a differentiated understanding of the working situation employees undergo in the last working years (Baltes *et al.*, 2012; Amick *et al.*, 2016). For this purpose, a person-centred approach was applied by means of finite mixture modelling, with the addition of incorporating a temporal dimension. The observed MTW differences between trajectory groups suggest a minimum timeframe of four years for successful implementation and the extent to which measures directed at improving job quality may be effective. Finally, the findings were obtained for two baby-boomer cohorts, representative for a large part of the German workforce who are about to transition to retirement in the near future (Schröder *et al.*, 2013; Steinwede *et al.*, 2015, 2018).

A limitation of the study is the measurement of MTW in the last assessment only, even though the authors are aware that it is preferred to account for previous MTW levels. It is possible that some workers with high MTW change their employer or occupation to maintain or even improve job quality, which implies reverse causation effects that cannot be investigated with the present study design. A further limitation is that not all possible trajectories (*cf.* Figure 2) could be investigated in detail, as it was necessary to select a subset of trajectories that enabled subsequent plausible hypotheses testing and interpretability. For this purpose, a larger proportion of participants and their respective job quality trajectories had to be discarded. Furthermore, some of the omitted trajectories were too small in group size to allow for further statistical consideration. Even for the selected trajectory groups, small group sizes (*e.g.* Nn= 38 in the RM–PQ–PQ group) still may have prevented the detection of reliable differences, as their dispersion was accordingly high.

## Concluding remarks

This study highlights the dynamic job quality situation of the baby-boomer generation in Germany and corroborates its importance for the changeability of MTW in later working life. From a scientific perspective, retirement research may profit from the longitudinal application of a person-centred approach to capture the older workforce in its complexity, as this proved useful in showing that experiencing different work environments in the later life course may have the potential to affect motivation to work longer. Moreover, when designing and implementing EWL strategies, the findings underline the need for policymakers to consider explicitly workers with long periods of poor job quality across later working life. Early interventions are needed, aiming to reconsider and sustainably improve quality of work to enable those with demanding work to stay longer in the labour market without further damage and disadvantage. This way, promoting longer working lives for workers with the resources available to postpone retirement would increase the overall efficiency and fairness of EWL measures.

**Author contributions.** MS and HMH designed the study, MS performed all analyses, MS wrote the first draft of the manuscript and NG and HMH contributed to its development. MS, NG and HMH critically reviewed and revised the manuscript and approved the final version.

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**Conflict of interest.** The authors declare no conflicts of interest.

**Ethical standards.** Each participant was fully informed about the aim and procedure of this study in written form prior to giving verbal consent to participate. The verbal consent was then documented by the interviewer. Willingness for continued participation (to Waves 2 and 3) required written consent with an additional verbal consent (documented) at the beginning of the respective interview. The procedure was approved by the state privacy advocate of the Federal Ministry of Labour and Social Affairs (data protection contracts dating from July 2010 (8104.1–14) and 27 September 2017 (8102.9–23)). Ethical approval for study design and performance, including verbal and written consent, was obtained from the Ethics Committee of the University of Wuppertal (dated from 5 December 2008 (Sch/Ei Hasselhorn) and 20 November 2017 (MS/BB 171025 Hasselhorn)).

## Notes

1 Cohort 1959: sex, $\chi^2(1) = 0.3$, $p = 0.581$; educational level, $\chi^2(2) = 1.0$, $p = 0.603$; weekly working hours, $\chi^2(2) = 1.1$, $p = 0.577$; self-rated health, $\chi^2(1) = 0.0$, $p = 0.944$. Cohort 1965: sex, $\chi^2(1) = 0.0$, $p = 0.907$; educational level, $\chi^2(2) = 5.5$, p = 0.065; weekly working hours, $\chi^2(2) = 1.7$, $p = 0.432$; self-rated health, $\chi^2(1) = 0.4$, $p = 0.525$.

2 The respective indices were calculated as follows (weighting indicated in square brackets). The ordinal "physical exposure" index is the summed-up indication (0 = no, 1 = yes) of working time spend sitting [1], bending, kneeling/lying/working above head [1], lifting heavy loads [1] or with repetitive movements [1]. Raw sum scores were transformed to range 0–100. The ordinal "working time quality" index comprised the summed-up indication (0 = no, 1 = yes) 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 four-item Copenhagen Psychosocial Questionnaire (COPSOQ) scale 'quantitative demands' [2] and the indication (0 = no, 1 = yes) 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 three-item COPSOQ scales 'influence at work' [1] and 'possibilities for development' [1], already ranging from 0 to 100. The metric "social environment" index comprised the two-item COPSOQ scale 'support from colleagues' [1] with range 0–100 and the dichotomous effort–reward imbalance 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 three-item COPSOQ scale 'quality of leadership' [3] with range 0–100 and the effort–reward imbalance 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. The COPSOQ scale was multiplied by 0.75 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, 1 = yes). The metric "earnings" index was calculated as the monthly equivalised household net income. The ordinal "prospects index" was the summed-up indication (0 = no, 1 = yes) 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 [1]. Raw sum scores were transformed to range 0–100. In the final LPA, the mixed scaling across indiceswas specified accordingly.

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**Study III**

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# 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

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## 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

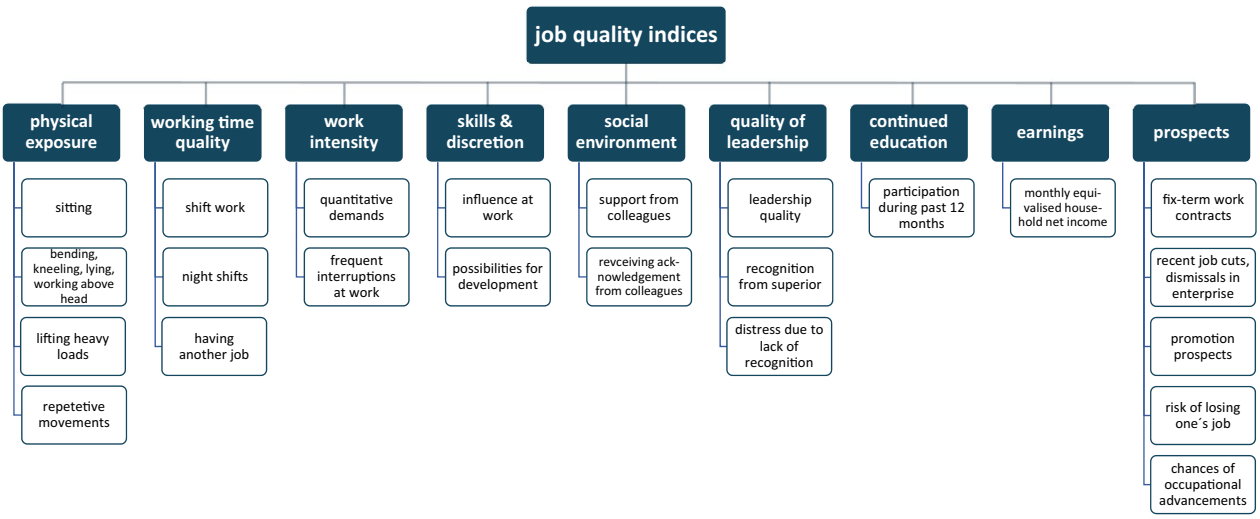



**Fig. 1** Content and composition of job quality indices in the present study (established by Hasselhorn et al. 2020)

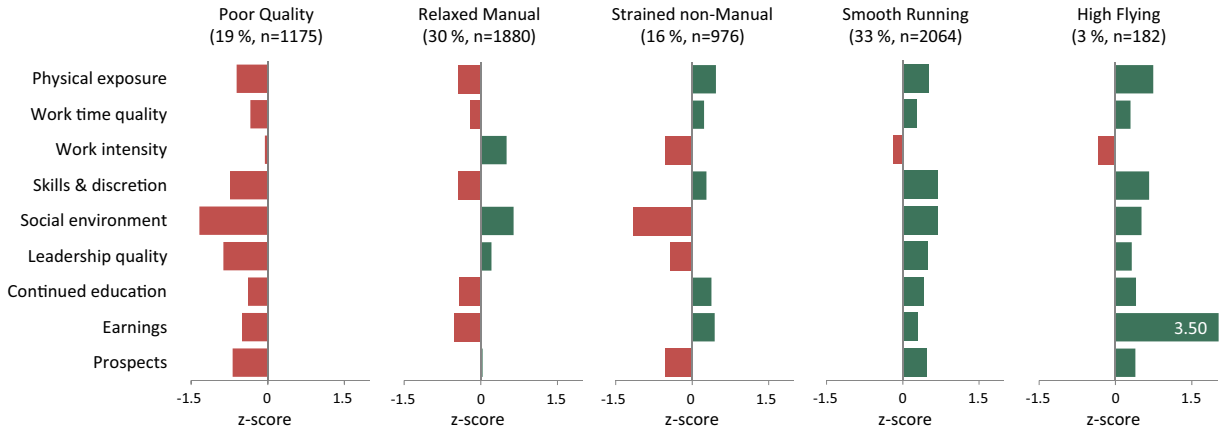



**Fig. 2** Distribution of job quality profiles among older employees in Germany (n = 6,277; 2011 data). Red = adverse manifestation, green = favourable manifestation; the earnings bar of the High Flying profile is shortened and the numerical z-score (= 3.50) displayed (adapted from Hasselhorn et al.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

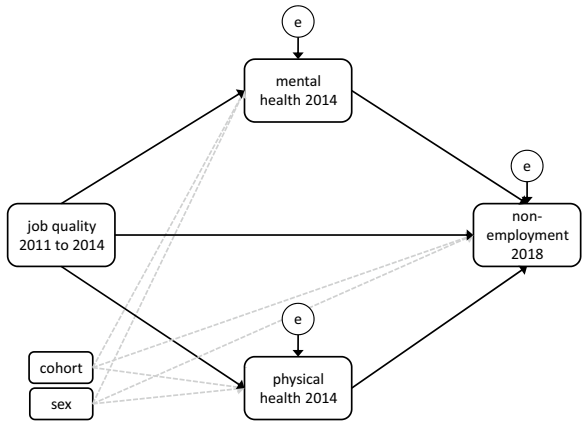



**Fig. 3** Parallel mediation models for job quality effects on non-employment. The models are separated for the respective manual and non-manual change groups according to their profile assignment in 2011 and 2014

[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 |

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### 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.

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### 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.

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**Curriculum Vitae**

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