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# Biomechanical and psychosocial occupational exposures: Joint predictors of post-retirement functional health in the French GAZEL cohort☆

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ABSTRACT

*Objectives:* Biomechanical and psychosocial occupational exposures are seldom considered simultaneously and over extended follow-up in occupational epidemiologic studies, although there is some evidence that combined exposures have interactive effects on workers' health during working life. Given high prevalence of functional disability among retirees, research on earlier-life determinants of subsequent functional outcomes can help shape workplace policies and practices. This study investigates whether health effects of combined occupational exposures during working life are observed after individuals retire and are no longer exposed.

*Methods:* Analyses were conducted among retirees in the French GAZEL occupational cohort ($n = 9168$). Cumulative exposure during working life to eight biomechanical strains and to one or more reports of psychosocial job strain (high-demand, low-control work) were assessed as predictors of three outcomes: difficulty with physical functioning, role limitations due to physical difficulties, and bodily pain. Individuals were classified by joint exposure to both biomechanical and psychosocial constraints. We modeled risk ratios (RR) between exposure to biomechanical and psychosocial factors at work (separately and in combination) and disability after retirement, and we calculated the relative excess risk due to interaction (RERI) to test whether combined effects departed from additivity.

*Results:* Both psychosocial and biomechanical exposures during working life were independent predictors of the three functional health outcomes. Compared with individuals who had neither biomechanical nor psychosocial exposures, in fully adjusted log-binomial models of the combined effects of biomechanical and psychosocial exposure, among those with low biomechanical exposures, the RR for physical functioning difficulties associated with psychosocial exposures was 1.18 (95% CI 1.01, 1.37). Among those with the



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highest levels of biomechanical exposures, RR was 1.42 (95% CI 1.21, 1.65) among those with low psychosocial exposures and 1.91 (95% CI 1.61, 2.26) among those with high psychosocial exposures. The two exposure types were modestly super-additive, with an RERI of 0.32 (95% CI 0.00, 0.62) between those with the highest and lowest levels of biomechanical exposures; if the effects were strictly additive, we would have expected an RERI of 0. For the other two outcomes results were similar, although there was no significant departure from additivity. Some effects varied in magnitude by gender.

*Conclusion:* Across the sample, combined biomechanical and psychosocial occupational exposures during working life appear to have additive or perhaps interactive effects on functional health in retirement. However, the relationship is less straightforward among women. Improving overall working conditions may lessen future disability among retirees.



## 1. Introduction

Functional status and capacity are major predictors of quality of life and mortality among the elderly (Newsom & Schulz, 1996; Reuben, Rubenstein, Hirsch, & Hays, 1992). There has been much research into midlife determinants of functional health in later life; pathways under investigation include chronic diseases (diabetes, arthritis, and cardiovascular disease) (Hung, Ross, Boockvar, & Siu, 2011) and health behaviors such as smoking and obesity (Sainio, Martelin, Koskinen, & Heliövaara, 2007). There is evidence that biomechanical and psychosocial occupational exposures are associated with functional health during working life. However, there is only a small body of research regarding the relationship between these exposures and physical and mental impairment in retirement, decades after exposures may have occurred (Calmels et al., 1998; Descatha et al., 2011; Wahrendorf et al., 2012).

Given high prevalence of disability among the elderly (Seeman, Merkin, Crimmins, & Karlamangla, 2010), examination of prior occupational risk factors for late-life disability is well-warranted, especially as life course models of health suggest that cumulative exposures over the life course may have profound impacts on health at older ages (Ben-Shlomo & Kuh, 2002; Kuh, Ben-Shlomo, Lynch, Hallqvist, & Power, 2003). Thus, modifying work environments may help prevent initial pathologies, interrupting a pathway through which individuals may become disabled later on. Furthermore, in analyses of both short- and long-term health effects of occupational exposures, hazards are often studied and treated individually. Yet the reality of most workplaces is that exposures do not occur in isolation, and risk factors often cluster with each other (MacDonald, Karasek, Punnett, & Scharf, 2001). Although examination of individual hazards is important for establishing causal relationships, to understand the potential health impact of co-occurring exposures, we must also assess potentially interactive, joint effects of the exposures.

Two or more occupational exposure types could have interactive effects on functional health outcomes in many ways; for example, among workers with high levels of biomechanical load, a workload too high to complete in the time allotted (high psychological demands) can increase risk for repetitive-strain injuries by reducing recovering time between physical tasks. Indeed, studies of combined effects of biomechanical and psychosocial exposures have found suggestions of interactive effects on short-term outcomes, such as concurrent prevalence of upper limb and neck disorders (Devereux, Vlachonikolis, & Buckle, 2002) and back disorders, although evidence is mixed (Devereux, Buckle, & Vlachonikolis, 1999; Huang, Feuerstein, Kop, Schor, & Arroyo, 2003; Vandergrift, Gold, Hanlon, & Punnett, 2012). These studies, while establishing the plausibility of interaction between exposure types, are mostly cross-sectional or use short-term health outcomes.

While research has thus considered biomechanical and psychosocial exposures as independent predictors of post-retirement health outcomes, and studies have tested whether the two exposure types have interactive effects on short-term health outcomes, the long-term interactive effects of these exposures has yet to be explored or established. The present study seeks to examine how individual and combined psychosocial and biomechanical occupational exposures during working life jointly predict disability after retirement. We hypothesized that biomechanical and psychosocial exposures would separately predict future disability, and that, when considered simultaneously, the two exposure types would be interactive, such that those exposed to both would have worse outcomes than expected, based on the sum of the relationships between each individual exposure and disability outcomes.

## 2. Methods

### 2.1. Study population

The GAZEL Cohort, established in 1989, is a prospective cohort study of 20,625 employees of the French national gas and electricity company (Electricité de France-Gaz de France/EDF-GDF). Each year individuals fill out a self-report questionnaire regarding occupational, health, and social factors. Further information about the cohort can be found elsewhere (Goldberg et al., 2007; Zins, Leclerc, & Goldberg, 2009). Of the original cohort, 19,411 were alive in 2007. We retained for analysis those who retired between 1995 and 2006. We did this in order to capture those who were working when exposures were assessed in the 1995 and 2006 surveys, but who were no longer accruing exposure when outcomes were assessed in 2007. This excluded 1911 individuals who retired pre-1995 and 1500 who retired in 2007 or later. Of the 16,000 eligible workers, 9674 (60%) had complete exposure and outcome