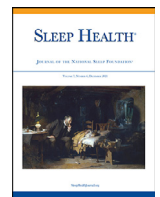


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## Daytime fatigue as a predictor for subsequent retirement among older New Zealand workers

Saana Myllyntausta, PhD<sup>a,b,\*</sup>, Rosemary Gibson, PhD<sup>a</sup>, Paula Salo, PhD<sup>c</sup>, Joanne Allen, PhD<sup>d</sup>, Philippa Gander, PhD<sup>a</sup>, Fiona Alpass, PhD<sup>d</sup>, Christine Stephens, PhD<sup>d</sup>

<sup>a</sup> Sleep/Wake Research Centre, Massey University, Wellington, New Zealand

<sup>b</sup> Department of Public Health, Faculty of Medicine, University of Turku and Turku University Hospital, Turku, Finland

<sup>c</sup> Department of Psychology and Speech-Language Pathology, Faculty of Social Sciences, University of Turku, Turku, Finland

<sup>d</sup> School of Psychology, Massey University, Palmerston North, New Zealand



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### ABSTRACT

**Objectives:** There is limited information on the role of fatigue on retirement, either independently or in association with poor sleep. The aim of this study was to examine the prospective association between daytime fatigue, measured as feeling tired or feeling worn out, independently and in relation to dissatisfaction with sleep, and subsequent retirement among 960 older workers in New Zealand.

**Methods:** Data from 2 consecutive surveys (2008 and 2010) of the New Zealand Health, Work, and Retirement Longitudinal Study were used. Poisson regression was used to investigate whether feeling tired and feeling worn out in 2008, along with dissatisfaction with sleep, were associated with self-reported retirement either due to health reasons or other reasons by 2010.

**Results:** The risk for retirement due to health reasons during a 2-year follow-up was 1.80-fold (95% confidence interval [CI] 1.16–2.45) among those who felt tired and 1.99-fold (95% CI 1.34–2.64) among those who felt worn out when compared to those not tired or not feeling worn out after adjusting for several sociodemographic, work characteristics and self-rated health. The risk for retirement due to health reasons was even higher when participant experienced both tiredness and feeling worn out. Dissatisfaction with sleep did not predict retirement due to health or other reasons.

**Conclusions:** Our results highlight that workers at risk of subsequent retirement due to health reasons may be identified with rather simple questions on tiredness and feeling worn out even among generally healthy older workers.

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### Introduction

As the “baby boom generation” reach retirement age, there are fewer workers to support the old-age population resulting in an increasing old age dependency ratio. To overcome these challenges, there is a pressure in most Western countries to increase and prolong labor force participation.<sup>1</sup> One possible avenue is to encourage and support people to postpone their retirement. To continue in employment, health and work ability need to be maintained, and thus, identifying factors that may jeopardize this is crucial.

Insufficient, poor quality sleep and daytime fatigue may be key factors deteriorating working capacity, as they have been

independently associated with impaired performance at work,<sup>2,3</sup> sickness absence,<sup>4–6</sup> work disability,<sup>7–9</sup> and with both poor mental and physical health.<sup>10,11</sup> While a body of evidence associates frequent insomnia symptoms and other sleep difficulties with subsequent disability retirement,<sup>9,12–15</sup> much less is known on the association of fatigue with exit from the labor force. Fatigue, often synonymous with tiredness or lack of energy, is prevalent among both general work force and older employees.<sup>16,17</sup> Fatigue may be the consequence of sleep loss, extended wakefulness, and disruptions of the normal sleep cycle, as well as relate to mental or physical workload.<sup>18,19</sup> We are aware of 2 studies that have examined the association of fatigue with early retirement or retirement intention.<sup>20,21</sup> A prospective study from the Netherlands observed that among a cohort of older workers, prolonged fatigue (measured with a scale covering several aspects of fatigue, such as severity, concentration problems, decreased motivation, and levels of physical activity) was associated with having early retirement intentions.<sup>20</sup>

\*Corresponding author: Saana Myllyntausta, PhD, Department of Psychology and Speech-Language Pathology, Faculty of Social Sciences, University of Turku, Turku FI-20014, Finland

E-mail address: [saana.myllyntausta@utu.fi](mailto:saana.myllyntausta@utu.fi) (S. Myllyntausta).

Using longitudinal cohort data from the United States, another prospective study observed that older workers who experienced fatigue (defined as “a symptom of tiredness or poor energy”) were less likely to retire during a 6-year follow-up than those who did not experience fatigue.<sup>21</sup> However, they were not able to differentiate between health- and nonhealth-related reasons for retirement. More research is, thus, needed on whether daytime tiredness is associated with actual retirement rather than just the intentions to retire.

Previous studies examining the association of poor sleep and fatigue with subsequent labor market exit have been mainly conducted with study populations from Northern Europe (Finland, Norway, and Sweden)<sup>9,12-15,22-24</sup> and the United States<sup>21,25,26</sup>; thus, further research is needed to examine whether these associations are evident in other cultural and associated employment contexts. Furthermore, the majority of work to date that has examined predictors of retirement, such as poor sleep, has focused on disability retirement and most data on retirement has been obtained from national pension registers.<sup>27</sup> Retirement due to less severe health issues or poor health in general may remain unexamined when using such data, as disability retirement is necessarily preceded by a diagnosis of a disease or chronic condition. Fatigue may not be sufficient reason for disability pension to be awarded but may predict a decision to retire. Thus, examining self-reported reasons for retirement may be more appropriate, when examining the association between fatigue and subsequent retirement. Such approach has been previously used in terms of insomnia symptoms, which were observed to predict retirement due to poor health, but less evidence was observed on their association with retirement due to nonhealth reasons.<sup>25,26</sup>

The primary aim of this study is to examine whether measures of fatigue—feeling tired or feeling worn out (in 2008)—are prospectively associated with subsequent retirement due to health reasons or other reasons (by 2010). We hypothesize that similarly to insomnia symptoms, feeling tired and feeling worn out predict retirement due to health reasons, but not due to other reasons. Furthermore, we aimed to examine how these variables were associated with subsequent retirement when combined with dissatisfaction with sleep. We hypothesize that people who are both dissatisfied with their sleep and either feeling tired or worn out have greater risk for retirement due to health reasons than those who are not dissatisfied with their sleep, but feel tired or worn out, given the previously observed associations between poor quality sleep and retirement due to health reasons.

## Method

### Study sample

The Health Work and Retirement (HWR) longitudinal study is a population-based study including a biennial survey of health and wellbeing among a large random sample of older adults in New Zealand. Respondents to the 2008 HWR survey were recruited to the longitudinal study in 2006 from a large random sample drawn from the New Zealand electoral roll, a compulsory voting register of New Zealanders aged 18 and over.<sup>28</sup> To ensure adequate representation of the indigenous people of Aotearoa New Zealand, an oversample of persons indicated as being of Māori descent was drawn. Characteristics of the 2006 sample have been described in detail elsewhere.<sup>29,30</sup>

In the 2008 HWR survey, questions relating to fatigue and dissatisfaction with sleep were included and used as baseline measurements (Time 1). Indicators of retirement and reasons for retirement were derived from the 2010 survey (Time 2). Of the 2,474 responses to the 2008 survey, 1,829 (74%) also responded to the 2010 follow-up survey. For the current analyses, participants who were in paid employment at baseline were included. Therefore, we excluded those who (1) reported their employment status as either “Retired, not paid

work” or “Unable to work due to health or disability issue” in 2008, (2) had missing or inconsistent information about their employment status in 2008 (i.e. employment status at baseline could not be defined), or (3) did not provide data on one or more indicator of sleep quality or fatigue (either dissatisfaction with sleep, feeling tired, or feeling worn out) in 2008 (Fig. 1). This resulted in an analytic sample of 1,140 participants. The study was conducted with approval from the Massey University Human Ethics Committee: Southern B Application 09/70.

### Assessment of outcome: Retirement

The primary outcome variable was retirement at Time 2. Respondents who were retired at Time 2 (either partly or completely) were asked to nominate their *main* reason for retirement or reducing work from a predefined list (see supplementary Table S1). We examined 2 different categories of main reasons for retirement: (1) having retired *due to health reasons* if the participant answered either “Forced due to poor health” or “Forced due to disability or injury” or (2) having retired *due to other reasons* if the participant indicated any other reason; for example, “Wanted to do other things”; “Felt it was time to retire”; “Became eligible for New Zealand Superannuation.” Those who did not consider themselves partly or completely retired were instructed to skip this item in the questionnaire and those respondents who did not answer this question were categorized as *not retired* and used as a reference group in the analyses. Retirement may have occurred any time within the 2-year follow-up period between Time 1 and Time 2.

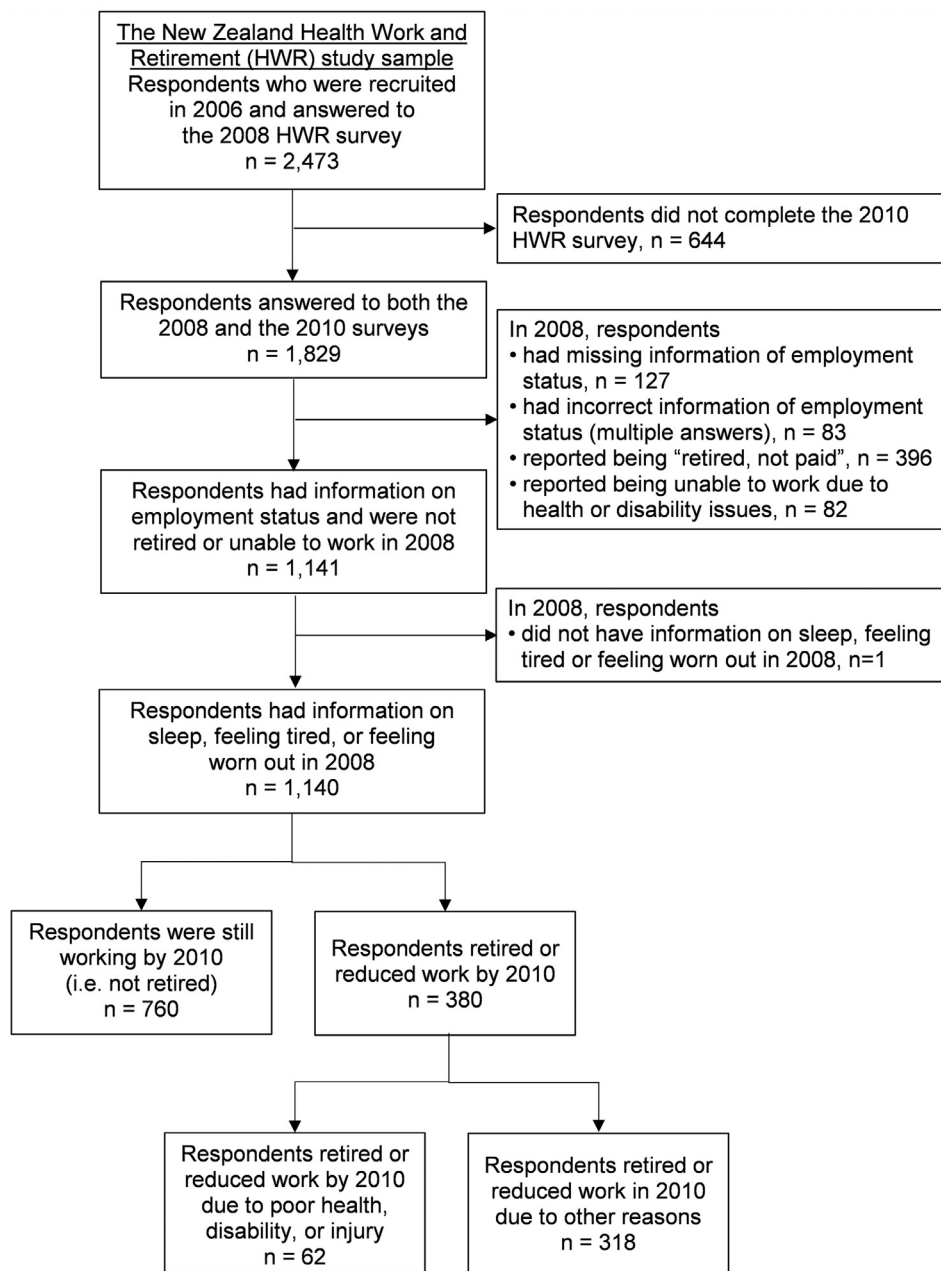
### Assessment of predictors: Feeling worn out, feeling tired, and dissatisfaction with sleep

Fatigue was defined as feelings of tiredness and exhaustion in this study. As predictor variables, we used participants’ responses on questions concerning feeling tired, feeling worn out and dissatisfaction with sleep at Time 1. More detailed description of these variables has been provided in supplementary Table S1. Participants rated how much of the time during the previous 4 weeks they had (1) felt tired, and (2) felt worn out using a 6-point scale (from 1 = All of the time to 6 = None of the time), administered within the Short Form 36 Question Health Survey (SF-36).<sup>31</sup> These 2 items are from the vitality scale of the SF-36, which measures energy levels and fatigue. Responses to each item were dichotomized into *yes* (some of the time—all of the time) or *no* (a little of the time—none of the time).<sup>32</sup> In addition, those participants who reported feeling tired and/or feeling worn out were categorized into either 1) feeling only tired or only worn out or 2) feeling both tired and worn out. Dissatisfaction with sleep was evaluated using a 5-point scale (1 = Very dissatisfied to 5 = Very satisfied), administered within the brief World Health Organization Quality of Life Measure.<sup>33</sup> Dissatisfaction with sleep was categorized into *yes* (very dissatisfied—dissatisfied) or *no* (neither satisfied nor dissatisfied—very satisfied).<sup>32</sup>

To examine how feeling tired and feeling worn out were associated with subsequent retirement when combined with dissatisfaction with sleep, we formed variables combining these measurements. Participants were categorized into having been *tired/feeling worn out and not dissatisfied with sleep* or *tired/feeling worn out and dissatisfied with sleep*.

### Assessment of covariates

Demographic indices were included as covariates. These included gender (male/female), age, and NZ Deprivation Index (NZDep 06). We used information on age both as a continuous variable (years) and as a binary variable (<65 years or ≥65 years; based on the age at



**Fig. 1.** Flow chart on the selection process of the final study sample (n = 1,140).

which people generally become eligible to draw a government pension, New Zealand Superannuation). NZDep 06 is an area-based measure of socio-economic deprivation, categorizing respondent's area of residence on a scale from 1 (least deprived) to 10 (most deprived) based on the geographical area and calculated based on 24,000 small areas that contain a median of approximately 90 people.<sup>34,35</sup> Information on ethnicity was obtained from the 2008 survey and categorized as Māori (if self-identified as Māori, either alone or as one of multiple ethnicities) or non-Māori. Ethnicity was included as a covariate, as it has been previously shown to be associated with sleep in New Zealand, with Māori adults (aged 20–59) reporting more sleep problems than non-Māori.<sup>36</sup>

Additional covariates characterizing health and conditions of employment from the 2008 survey were included on an a priori basis.<sup>25</sup> Employment status was categorized as full time, part-time, or other (eg, being a full-time homemaker, unemployed, or seeking

work). Shift work status (yes vs. no) was based on whether participants reported regularly performing shift work. Job demands were assessed by asking participants to evaluate whether they had to work very fast or intensively, whether the work demanded too much effort, and whether they had enough time to do everything, using a 4-point scale from 1 (Never) to 4 (Often).<sup>37</sup> Participants within the upper quartile of the total scores represented those with high job demands (yes vs. no). Self-rated health was assessed with a 5-point scale (1 = excellent to 5 = poor) and categorized into excellent/very good, good, and fair/poor.

#### Statistical analyses

Included cases (n = 1,140) had complete data on employment status at baseline and retirement outcome at Time 2. In light of small proportions of missing data by variable (reported in Table 1) and case

**Table 1**  
Baseline characteristics of the study population (n = 1,140) in 2008 and by the subsequent retirement status in 2010.

Baseline characteristics	Total (n = 1,140)	Retired due to health reasons (n = 62)	Retired due to other reasons (n = 318)	Did not retire (n = 760)	p value
	M (SD)/n (%)	M (SD)/n (%)	M (SD)/n (%)	M (SD)/n (%)	
Age	61.9 (4.1)	63.0 (4.6)	64.4 (3.9)	60.7 (3.6)	<.0001
Gender					.311
Male	560 (49)	27 (44)	148 (47)	385 (51)	
Female	580 (51)	35 (56)	170 (53)	375 (49)	
Ethnicity: Māori					<.0001
No	710 (62)	34 (55)	197 (62)	479 (63)	
Yes	430 (38)	28 (45)	121 (38)	281 (37)	
Employment status					<.0001
Full-time	628 (55)	22 (35)	74 (23)	532 (70)	
Part-time	411 (36)	27 (44)	187 (59)	197 (26)	
Other	101 (9)	13 (21)	57 (18)	31 (4)	
Shift work					<.0001
No	889 (78)	48 (77)	226 (71)	615 (81)	
Yes	125 (11)	3 (5)	18 (6)	104 (14)	
Missing	126 (11)	11 (18)	74 (23)	41 (5)	
High job demands					<.0001
No	704 (69)	31 (50)	210 (66)	463 (61)	
Yes	311 (31)	19 (31)	36 (11)	256 (34)	
Missing	125 (11)	12 (19)	72 (23)	41 (5)	
Self-rated health					<.0001
Excellent/very good	660 (60)	20 (32)	164 (52)	476 (63)	
Good	352 (32)	21 (34)	124 (39)	207 (27)	
Fair/poor	92 (8)	20 (32)	20 (6)	52 (7)	
Missing	36 (3)	1 (2)	10 (3)	25 (3)	
Predictors					
Feeling tired					.0003
No	543 (48)	15 (24)	156 (49)	372 (49)	
Yes	573 (50)	47 (76)	151 (47)	375 (49)	
Missing	24 (2)	0 (0)	11 (3)	13 (2)	
Feeling worn out					<.0001
No	726 (64)	24 (39)	199 (63)	503 (66)	
Yes	387 (34)	37 (60)	107 (34)	243 (32)	
Missing	27 (2)	1 (2)	12 (4)	14 (2)	
Dissatisfaction with sleep					.064
Not dissatisfied	906 (79)	46 (74)	265 (83)	595 (78)	
Dissatisfied	207 (18)	16 (26)	49 (15)	142 (19)	
Missing	27 (2)	0 (0)	4 (1)	23 (3)	

(n = 921 had complete data on all predictors, covariates and outcome variables, with 98.9% of cases missing less than 3), to reduce biases associated with exclusion due to missing data, multiple imputation datasets (n = 10 sets) were generated using Bayesian estimation as implemented in MPLUS 8.4 prior to primary regression analyses. Descriptive statistics for the study population are provided as frequencies and percentage for categorical variables and as mean and standard deviation (SD) for age for the whole study sample and by retirement status. The univariate association of baseline predictors and covariates with retirement status at Time 2 was assessed using chi-square analysis for categorical variables and ANOVA for age.

Individual Poisson regression models were used to examine whether each predictor—feeling tired, feeling worn out, and dissatisfaction with sleep—predicted retirement either due to health reasons or other reasons by Time 2. In addition, we examined whether feeling both tired and worn out was associated differently to retirement due to health reasons or other reasons than feeling only either tired or worn out. To investigate the impact of covariates, the analyses were first adjusted for sociodemographic covariates: gender, age (as continuous age \* binary age [ $<65$  years or  $\geq 65$  years] interaction), NZDep06, and ethnicity (Model 1). The analyses were then additionally adjusted for work-related factors: employment status, shift work, and job demands (Model 2). Finally, the analyses were additionally adjusted for self-rated health at Time 1 (Model 3). Results are provided as risk ratios (RR) and their 95% confidence intervals (CI). Those who were not retired by Time 2 served as the reference group in the regression models.

To examine whether the observed associations were different depending on whether the participant was dissatisfied with sleep in addition to feeling tired or feeling worn out, the combination of feeling tired or worn out with dissatisfaction with sleep was examined as a predictor for retirement at Time 2 with the abovementioned adjustments (Models 1–3). All analyses were conducted using the SAS 9.4 Statistical Package (SAS Institute Inc., Cary, NC).

## Results

Participants' characteristics at baseline are shown in Table 1. Average age was 61.9 years (SD = 4.1), with 74% under the age of 65 years. Of the study population, 51% were women, 38% identified as Māori, 55% were working full-time, and 11% did regular shift work. All deciles of the NZDep 2006 were represented in this study population with the highest number of participants in the least deprived decile (12%) and lowest number in the most deprived decile (8%). Overall, 60% rated their health as either very good or excellent and 79% were not dissatisfied with their sleep. However, 48% reported feeling tired and 34% reported feeling worn out. From the participants who felt tired and/or worn out, 57% felt both tired and worn out and 43% only either tired or worn out. From those who reported feeling tired, 149 (27%) were dissatisfied with their sleep and 412 (73%) were not. From those who felt worn out, 116 (31%) were dissatisfied with their sleep and 263 (69%) were not. Characteristics of the analysis sample (n = 1,140) were generally comparable to those of the full cohort at 2008 (N = 2,473). The full 2008 cohort was slightly

older ( $M = 63.2$ ,  $SD = 2.9$ ) and more respondents rated their health as fair/poor (15%) and reported feeling tired (55%) or worn out (39%) than among those included in the analytic sample.

Among the 1,140 participants included in the analyses, 33% retired by Time 2 ( $n = 380$ ): 62 had retired due to health reasons, and 318 due to other reasons. As seen in Table 1, those who had retired due to health or other reasons were on average slightly older and less likely to have been working full-time or to have regularly been doing shift work at Time 1 than those who had not retired during the follow-up period. In addition, those who retired due to health reasons were more likely to report their health as fair/poor and to be feeling tired or feeling worn out than those in the other groups. The NZDep profile of participants did not differ significantly by retirement status ( $\chi^2 = 20.5$ ,  $p = .425$ ).

Table 2 shows the associations between feeling worn out, feeling tired, and sleep dissatisfaction with subsequent retirement. When adjusting for demographic characteristics, those who reported feeling tired at Time 1 were more likely to retire due to health reasons compared with those who did not ( $RR = 2.67$ , 95% CI 2.08–3.26, Model 1). Similarly, those who reported feeling worn out were more likely to retire due to health reasons compared with those who did not ( $RR = 2.65$ , 95% CI 2.10–3.20; Model 1). Those who felt both tired and worn out were more likely to retire due to health reasons than those who felt either only tired or only worn out ( $RR = 2.32$ , 95% CI 1.59–3.04; Model 1). When additionally adjusting for work characteristics (Model 2), the associations between feeling tired, feeling worn out, or both with retirement due to health reasons remained statistically significant. Finally, when adjusting for self-rated health (Model 3), these associations were slightly attenuated, but remained statistically significant. There were no statistically significant associations between feeling tired, feeling worn out, or both with retirement due to reasons other than health. In addition, dissatisfaction with sleep was not associated with retirement due to either reason.

Results from the 3 models assessing the combination of feeling tired with sleep dissatisfaction and feeling worn out with sleep dissatisfaction are presented in Table 3. These combination variables were only assessed in terms of those associations that were previously observed to be statistically significant, that is as predictors for retirement due to health reasons. For the combination of feeling tired and dissatisfaction with sleep, the sample size used in these analyses

ranged from 424 to 430 and for the combination of feeling worn out and dissatisfaction with sleep it ranged from 283 to 288 due to the application of multiple imputation datasets. No differences were observed in the risk for retirement due to health reasons between those who were feeling tired or worn out and dissatisfied with sleep when compared to those who were feeling tired or worn out and not dissatisfied with their sleep.

## Discussion

This is among the first prospective studies to examine how fatigue predicts retirement among an older population outside Northern Europe or the United States. In this study of older New Zealand workers, those who felt tired or worn out were more likely to retire due to health reasons during a 2-year follow-up period than those without these experiences. Previous studies on self-reported reasons for retirement have similarly shown that insomnia symptoms are associated with labor market exit due to poor health rather than due to nonhealth reasons.<sup>25,26</sup> We extended previous research by showing that fatigue is not only association with intentions to retire early from work, as has been observed previously,<sup>20</sup> but also actual retirement from work.<sup>20</sup> However, our findings are in contradiction with the recent results by Sagherian et al<sup>21</sup> that showed fatigue being associated with lower likelihood of job exit compared to those with no fatigue, which might be explained by not being able to differentiate health reasons and other reasons for job exit and the population being over 10 years older in their study compared to the current study.

This study shows that with simple questions on tiredness and feeling worn out it was possible to predict subsequent retirement due to health reasons among older workers who, at baseline, were relatively healthy (with only 8% rating their health as fair or poor) and able to work (with those unable to work due to poor health having been excluded). The risk for retiring due to health reasons were almost 2-fold among those feeling tired and those feeling worn out compared to those not, after controlling for demographic characteristics, work characteristics, and self-rated health. Furthermore, the risk for retirement due to health reason was even higher among those who were both tired and worn out when compared to those feeling only tired or only worn out. This finding suggests that fatigue may

**Table 2**  
Poisson regression models of the association of each predictor—feeling tired, feeling worn out, and dissatisfaction with sleep—with subsequent retirement due to health reasons or retirement due to other reasons by 2010.

	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>		Model 3 <sup>c</sup>	
	Retired due to health reasons vs. did not retire by Time 2 ( $n = 822$ )	Retired due to other reasons vs. did not retire by Time 2 ( $n = 1,078$ )	Retired due to health reasons vs. did not retire by Time 2 ( $n = 822$ )	Retired due to other reasons vs. did not retire by Time 2 ( $n = 1,078$ )	Retired due to health reasons vs. did not retire by Time 2 ( $n = 822$ )	Retired due to other reasons vs. did not retire by Time 2 ( $n = 1,078$ )
	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Feeling tired						
No	Reference	Reference	Reference	Reference	Reference	Reference
Yes	<b>2.67 (2.08–3.26)</b>	1.00 (0.78–1.23)	<b>2.58 (1.97–3.18)</b>	1.00 (0.78–1.23)	<b>1.80 (1.16–2.45)</b>	0.96 (0.73–1.20)
Feeling worn out						
No	Reference	Reference	Reference	Reference	Reference	Reference
Yes	<b>2.65 (2.10–3.20)</b>	1.10 (0.86–1.34)	<b>2.64 (2.01–3.26)</b>	1.08 (0.84–1.33)	<b>1.99 (1.34–2.64)</b>	1.05 (0.79–1.30)
Feeling tired + feeling worn out						
Feeling only tired or only worn out	Reference	Reference	Reference	Reference	Reference	Reference
Feeling both tired and worn out	<b>2.32 (1.59–3.04)</b>	0.94 (0.64–1.24)	<b>2.39 (1.61–3.17)</b>	1.00 (0.69–1.30)	<b>2.08 (1.30–2.87)</b>	0.97 (0.65–1.28)
Dissatisfaction with sleep						
Not dissatisfied	Reference	Reference	Reference	Reference	Reference	Reference
Dissatisfied	1.55 (0.97–2.12)	0.94 (0.64–1.25)	1.53 (0.94–2.13)	0.95 (0.64–1.26)	1.14 (0.53–1.76)	0.95 (0.64–1.25)

Statistically significant results have been bolded.

<sup>a</sup> Adjusted for age, gender, ethnicity, and NZDep Index in 2006.

<sup>b</sup> Additionally adjusted for employment status, shift work, and job demands in 2008.

<sup>c</sup> Additionally adjusted for self-rated health in 2008.



**Table 3**

Poisson regression models of the association of the combination of feeling tired with dissatisfaction with sleep and feeling worn out with dissatisfaction with sleep and subsequent retirement due to health reasons.

	Model 1 <sup>a</sup>			Model 2 <sup>b</sup>			Model 3 <sup>c</sup>		
	Retired due to health reasons vs. did not retire by Time 2			Retired due to health reasons vs. did not retire by Time 2			Retired due to health reasons vs. did not retire by Time 2		
	RR	95% CI		RR	95% CI		RR	95% CI	
Feeling tired + dissatisfaction with sleep									
Yes + No	Reference			Reference			Reference		
Yes + Yes	1.31	0.69	1.93	1.29	0.66	1.92	1.07	0.43	1.72
Feeling worn out + dissatisfaction with sleep									
Yes + No	Reference			Reference			Reference		
Yes + Yes	1.22	0.55	1.89	1.21	0.53	1.90	0.97	0.27	1.67

<sup>a</sup> Adjusted for age, gender, ethnicity, and NZDep Index in 2006.

<sup>b</sup> Additionally adjusted for employment status, shift work, and job demands in 2008.

<sup>c</sup> Additionally adjusted for self-rated health in 2008.

predict retirement due to health reasons in a few years' time regardless of health at the time. These results show that assessing older workers fatigue along with their sleep be a useful way of detecting those workers at risk of early retirement due to health reasons and supporting their health and workability.

As stated by Haaramo et al<sup>9</sup> it is valuable to examine daytime impairment due to insomnia symptoms and its association with subsequent retirement. Daytime impairment caused by sleep disturbance is included in the diagnostic criteria for insomnia in the current Diagnostic and Statistical Manual of Mental Disorders.<sup>38</sup> For this reason, we also examined how feeling tired or worn out were associated with retirement due to health reasons when combined with being dissatisfied with sleep or not. Contrary to our hypothesis, those who were both either feeling tired or feeling worn out and dissatisfied with their sleep did not have a greater risk for retirement due to health reasons when compared to those among who feeling tired or feeling worn out was not accompanied by dissatisfaction with sleep. The survey used in this study was not designed with sleep as the primary measure and more sensitive measures of sleep duration and sleep quality would have been needed to examine whether the experiences of fatigue arose from insufficient or poor quality sleep. Future studies should examine whether there is a mediating effect of fatigue on the association between poor sleep and retirement due to health reasons.

Dissatisfaction with sleep alone was not associated with subsequent retirement due to health or nonhealth reasons. This finding is somewhat surprising, as poor sleep quality and insomnia symptoms have been observed to predict both retirement due to self-reported poor health<sup>25,26</sup> as well as register-based disability retirement.<sup>9,15,23,24</sup> Dissatisfaction with sleep may arise from various reasons: a person might be dissatisfied with sleep even when having only mild or occasional insomnia symptoms that are not affecting his/her sleep quality or daily functioning significantly. The variability in the experience of being dissatisfied with sleep might explain why no associations were found with subsequent retirement.

A major strength of this study is the information on various covariates, which allowed us to control for their effects on the examined associations. Furthermore, by examining self-reported reasons for retirement we may capture nonclinical conditions that affect workability and may lead to retirement due to health reasons but would not necessarily grant the person a disability pension.

This study has some limitations. Firstly, model predictors, self-reported feelings of tiredness and feeling worn-out, were limited in their response options and representation of the construct of interest. While the current indicators were selected as well validated indicators of fatigue as assessed in the Short Form Health Survey, this research

may be strengthened by inclusion of additional indicators enabling more comprehensive assessment of the specific latent construct of daytime fatigue. Secondly, the question concerning the main reason for retirement did not differentiate between those retiring part-time or full-time, and it was not possible to differentiate the predictive value of daytime fatigue in retirement from part-time and full-time employment. Indeed, while literature on retirement has often by definition focused on retirement from full-time, permanent employment roles, research into transitions from part time work have great potential to increase representation of this research field to include experiences of those who have experienced lifetime trajectories of less-secure attachment to the workforce, such as experienced by women and caregivers.<sup>39,40</sup> We note that while the longitudinal design as a strength of the current research, exact timing of retirement over the follow-up period was not available in the existing datasets and retirement may have occurred any time within the 2-year follow-up period—future research assessing time-to-retirement may provide further insight into the strength of the association of daytime fatigue with retirement from the workforce. Thirdly, in comparison to the full 2008 cohort (N = 2,473), participants in the final sample (n = 960) were slightly younger and less likely to rate their health as fair/poor or report feeling tired or feeling worn out. This may limit the generalizability of our findings. Finally, some of the results in terms of health-related retirement might lack statistical power, as only 62 participants retired due to health reasons.

In conclusion, we observed that among older New Zealand workers, fatigue—indicated by reporting feeling tired or feeling worn out—was associated with greater risk for retirement due to health reasons during a 2-year follow-up period. If the participant experienced both feeling tired and feeling worn out, the risk for retirement was even higher than among those experiencing just one symptom. Dissatisfaction with sleep was not associated with greater risk for retirement due to health reasons or other reasons, neither separately or when in combination with feeling tired or feeling worn out. Further research is needed on whether fatigue has a mediating role in the association between poor sleep and subsequent retirement due to health reasons.

#### Declaration of conflict of interest

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## Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.sleh.2021.08.010.

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