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Transitioning out of work and metabolic syndrome incidence: a longitudinal study among 13 303 older workers from the Lifelines Cohort Study and Biobank

Katharina Runge 1,2, Sander K. R. van Zon 1,2, Ute Bültmann 1,2, Kène Henkens 1,2,3

ABSTRACT
Background This study investigates (1) whether different employment transition types (ie, unemployment, work disability, early retirement and regular retirement) are associated with metabolic syndrome (MetS) incidence among older workers (50–64 years) and (2) whether occupational group moderates the association between employment transition type and MetS incidence.

Methods A sample of 13 303 older Dutch workers from the Lifelines Cohort Study and Biobank was examined using longitudinal data from two comprehensive measurement waves with a mean follow-up time of 3.7 years. MetS components were based on physical measures, blood markers and medication use. Employment transitions were determined using questionnaires. Logistic regression analysis was performed to examine the association between employment transition type and MetS incidence.

Results Older workers who transitioned from employment to unemployment (adjusted OR 1.39, 95% CI 1.05 to 1.82) or work disability (adjusted OR 1.89, 95% CI 1.15 to 3.10) had a significantly higher MetS incidence than the working control group. No association between early retirement or regular retirement with MetS incidence was found after adjusting for sociodemographic, educational and occupational factors. Occupational group did not moderate the association between employment transition type and MetS incidence.

Conclusion The results suggest that older workers who transition from employment to unemployment or work disability are at risk for developing MetS. More awareness among occupational physicians and general practitioners about MetS incidence in late working life is needed in general and more specific among older workers who transition into unemployment or work disability.

INTRODUCTION
Employment transitions in late adulthood are complex and heterogeneous and can influence long-term cardiovascular and metabolic health outcomes.1,2 Older workers transition out of employment in conceptually different ways. They may transition out of employment through early retirement (ie, retiring before the state pension age), regular retirement (ie, retiring at the state pension age), unemployment (ie, being available for the labour market but out of employment while actively searching for a job), or work disability (ie, the inability to execute or obtain work due to long-lasting ill health).3,5 Based on previous research, we consider transitions from employment to early retirement and regular retirement as more voluntary and from employment to unemployment and work disability as more involuntary.6 Previous studies suggest adverse mental and physical health outcomes of involuntary employment transitions and better mental and physical health outcomes of voluntary employment transitions.6-10 However, evidence regarding the effect of employment transition types on objectively measured metabolic health outcomes is scarce and inconclusive. A relevant objective health outcome among older workers,
which might be affected by employment transition type, is the metabolic syndrome (MetS).\textsuperscript{11,12} MetS is a growing worldwide epidemic and encompasses at least three out of the following five risk factors for cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM): hypertension, abdominal obesity, raised fasting plasma glucose, raised triglycerides and lowered high-density lipoprotein (HDL) cholesterol.\textsuperscript{13,14} Having MetS is associated with a fivefold risk for developing T2DM and a twofold risk for developing CVD.\textsuperscript{11} MetS risk increases with age and the incidence is comparable to T2DM incidence, which peaks at 25\% around the age of 65.\textsuperscript{15} The underlying mechanism is an age-associated increase of abdominal obesity which facilitates insulin resistance and dyslipidaemia.\textsuperscript{15} Key health behaviours related to MetS incidence are smoking, physical activity, diet quality and alcohol consumption.\textsuperscript{15,16} Previous studies suggest MetS incidence differences by occupational group, ie, higher MetS incidence rates among lower skilled and blue-collar occupations.\textsuperscript{11,17} Moreover, a higher number of MetS components at the age of 60 is associated with early death after retirement.\textsuperscript{18}

To date, only a few studies have investigated the effect of employment transition type on MetS incidence among older workers.\textsuperscript{12} Two longitudinal studies investigated MetS incidence after transitioning from employment to retirement and unemployment, and another two longitudinal studies examined the effect of retirement on metabolic biomarkers.\textsuperscript{19-21} Findings from these studies are inconclusive: Behncke reported a significantly increased MetS incidence risk among retirees compared with a working control group.\textsuperscript{20} Gorry and Slavov found no consistent effect of retirement on MetS biomarkers.\textsuperscript{19} Pedron et al found increased cholesterol levels among regular retirees and an increased body mass index among early retirees.\textsuperscript{21} Retirement—irrespective of the timing—was associated with increased blood pressure.\textsuperscript{1} Lastly, Mirmiran et al found an increased MetS incidence risk among a selective sample of women who became unemployed.\textsuperscript{21} No studies about the effect of becoming work disabled in late adulthood on MetS incidence were identified.

A reason for these inconclusive findings might be of conceptual nature. First, it is important to distinguish between employment transition types as they generally differ in their level of voluntariness.\textsuperscript{6} Involuntary employment transitions are potentially associated with worse metabolic health outcomes than voluntary transitions due to less perceived financial control, or adverse health behaviour changes like an increase in alcohol and tobacco consumption.\textsuperscript{12} The few existing studies on employment transitions and metabolic health outcomes focus specifically on voluntary employment transition types or only on unemployment.\textsuperscript{19-21} No studies were identified which simultaneously investigate the effect of early retirement, regular retirement, unemployment and work disability on MetS incidence. Second, the association between employment transition types and MetS incidence might differ by occupational group membership as the effect of employment transitions on physical health depend on socioeconomic position.\textsuperscript{7} Generally, a more positive health effect is observed after voluntary employment transitions among older workers with higher socioeconomic position.\textsuperscript{7}

The aims of this study are (1) to examine the association between employment transition type and MetS incidence and (2) to investigate whether occupational group moderates the association between employment transition type and MetS incidence.

**METHODS**

**Study design and sample**

The current longitudinal study was embedded within the large-scale, population-based Lifelines Cohort Study and Biobank.\textsuperscript{23} Lifelines is a multidisciplinary prospective cohort study examining the health and health behaviours of 167,729 persons living in the North of the Netherlands. Lifelines employs a broad range of investigative procedures in assessing the biomedical, sociodemographic, behavioural, physical and psychological factors, which contribute to the health and disease of the general population. Eligible participants and their family members were recruited through general practitioners (GPs) and online self-registration.\textsuperscript{24} The ongoing data collection started in 2007 with a comprehensive baseline assessment (T0) at a Lifelines research centre, which included filling out questionnaires, collecting biological samples and a physical examination.\textsuperscript{23} On average every 1.5 years, follow-up questionnaires are completed (T1 and T2). After approximately 5 years, participants revisited a Lifelines research centre for the second comprehensive assessment (T3).\textsuperscript{23}

Sample inclusion criteria for the current study were: 50–64 years at T0 (ie, before the statutory retirement age of 65 years and 2 months in the Netherlands at the point of assessment), working ≥12 hours per week, complete MetS components data, no MetS at T0, and employment states of interest at T3.\textsuperscript{25,26} Participants with missing information on employment status at T3 (N=989) were included if they reported an employment status of interest at T1 or T2. We excluded participants in the occupational group ‘armied forces’ as there are no specified corresponding tasks which complicates the categorisation into white-collar or blue-collar workers.\textsuperscript{27} The flow chart of participant inclusion is displayed in figure 1. The analytical sample consisted of N=13,303 participants.

**Measures**

**Metabolic syndrome**

MetS was assessed at T0 and T3 using the joint interim criteria (figure 2).\textsuperscript{13} To classify for MetS, at least three out of five components need to be present: abdominal obesity (waist circumference (WC)≥88 cm in females, WC≥102 cm in males), raised triglycerides (≥1.7 mmol/L) or medication to treat lipid abnormalities (Anatomical Therapeutic Chemical (ATC) code C10A or C10B), lowered HDL-Cholesterol (<1.0 mmol/L in males, <1.3 mmol/L in females) or medication to treat lipid abnormalities (ATC code C10A or C10B), hypertension (systolic ≥130 and/or diastolic ≥85 mm Hg) or hypertension treatment (ATC code C02, C03, C07, C08, or C09), raised fasting glucose (≥5.6 mmol/L) or medication for T2DM (ATC codes A10A or A10B).\textsuperscript{13,28} MetS components were measured by trained research personnel using standardised protocols and calibrated measuring apparatus.\textsuperscript{17,23} WC was measured in the middle between the front end of the lower ribs and the iliac crest in an upright position. Triglycerides, HDL-cholesterol and fasting glucose were assessed by fasting blood samples. Systolic and diastolic blood pressure was measured using an automatic blood pressure monitor and the mean value of the final three measurements was recorded. Medical ATC codes were documented at T0 only.

**Employment transitions**

Employment status was measured by the question ‘Which situation applies to you?’ with the following answer options: paid work (including the number of hours per week), unemployment, work disability, homemaker, student, retirement (age 65), early
retirement or other. Based on T3 employment states of interest, employment transitions were compiled: unemployment, work disability, early retirement and regular retirement (Figure 2). Further, a working control group (ie, still working ≥12 hours per week) was included. Irrespective of which transition out of employment occurred, every participant will be regular retired once reaching the state pension age. Consequently, we further investigated whether regular retired participants at T3 (N=783) transitioned from employment at T1 or T2 to unemployment, work disability or early retirement; or if they were in employment until reaching the statutory retirement age. The last known employment status before regular retirement at T3 was decisive for the employment transition type or the age in remaining cases. For participants with missing information on T3 employment status, the last known employment status at T1 or T2 was decisive.

Sociodemographic factors
Age, sex, weekly working hours, occupational group and educational level were self-reported at T0; marital status was self-reported at T3 (Figure 2). Occupational group membership was coded according to the International Standard Classification of Occupations (ISCO) 08 by Statistics Netherlands. Based on the major ISCO-08 groups, four occupational categories were compiled: high skilled white-collar (managers, professionals, technicians and associate professionals), low skilled white-collar (clerical support workers, services and sales workers), high skilled blue-collar (skilled agricultural forestry and fishery workers, craft and related trades workers) and low skilled blue-collar workers (plant and machine operators and assemblers, elementary occupations). Educational level was categorised into low, medium, high or other. Marital status was coded as married/partnered or not married/partnered.

Multiple imputation
Multiple imputation was performed to deal with missing values on marital status (N=986), occupational group membership (N=361), working hours (N=110) and educational level (N=8).32 Imputations were predicted by age, sex, follow-up time, employment transitions and follow-up MetS status. In total, 20 datasets were imputed.

Statistical analyses
First, the distribution of T0 sociodemographic characteristics was examined for the total sample and by employment transition type. Second, the distribution of T0 and T3 MetS components was investigated by employment transition type. Third, MetS incidence rates were examined by employment transition type. Logistic regression analysis with stepwise covariate adjustment was performed to assess the association between employment transition type and MetS incidence. Specifically, we adjusted for follow-up time (model 1), age, sex, marital status (model 2) and weekly working hours, occupational group and educational level (model 3). Lastly, we tested whether occupational group moderates the association between employment transition type and MetS incidence by adding an interaction term to model 3. Follow-up time between T0 and T3 was included to adjust for varying follow-up times of participants. Age and sex were included due to the age-associated MetS increase and higher MetS incidence rates observed among males in previous studies. Marital status was included because having a partner can positively influence health outcomes after involuntary employment transitions. Working hours, occupational group membership and educational level were adjusted for the effect of educational and occupational factors on MetS incidence.

Two sensitivity analyses were conducted to examine the robustness of the results. We repeated our main analyses (1)
excluding participants who have T2DM at T0, and (2) including participants who work <12 hours per week at T0.

IBM SPSS Statistics V.25 was used to perform all data analyses and multiple imputation.

RESULTS
Sample characteristics
The total sample (N=13,303) mean age was 54.5 (SD: 4.0) years and included somewhat more women (53.1%) (table 1). In total, N=1911 participants transitioned out of employment during the mean follow-up time of 3.7 (SD: 1.00) years into unemployment (N=551), work disability (N=124), early retirement (N=700) and regular retirement (N=536). Baseline characteristics differed by employment transition type. Participants who became unemployed or work disabled were roughly 1.5 years older than the working control group (mean: 53.7 years, SD: 3.4) whereas participants who retired early or regularly were on average 6.3 and 8.9 years older, respectively. High skilled white-collar and blue-collar workers were more likely to transition from employment to early or regular retirement. Low skilled white-collar and blue-collar workers were more likely to transition from employment to unemployment or work disability. Lastly, N=2887 (15.9%) participants were lost to follow-up. Compared with the study sample, the drop-out sample included more blue-collar workers (21.6% vs 17.5%) and the baseline prevalence of abdominal obesity and hypertension was higher (32.8% vs 28.6% and 46.9% versus 43.3%, respectively).

MetS components distribution by employment transition type
Among all employment transitions, hypertension was most prevalent at T0 and T3 and—except for work disability—also increased the most in prevalence (table 2). Participants who

<table>
<thead>
<tr>
<th>Sociodemographic factors</th>
<th>Total sample</th>
<th>Employment transition type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>54.5 (4.0)</td>
<td>53.7 (3.4)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>53.1</td>
<td>53.4</td>
</tr>
<tr>
<td>Male</td>
<td>46.9</td>
<td>46.6</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/partnered</td>
<td>89.6</td>
<td>89.9</td>
</tr>
<tr>
<td>Not married/partnered</td>
<td>10.4</td>
<td>10.1</td>
</tr>
<tr>
<td>Weekly working hours</td>
<td>31.4 (8.5)</td>
<td>31.8 (8.4)</td>
</tr>
<tr>
<td>Occupational group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High skilled white-collar</td>
<td>52.7</td>
<td>52.8</td>
</tr>
<tr>
<td>Low skilled white-collar</td>
<td>29.8</td>
<td>29.7</td>
</tr>
<tr>
<td>High skilled blue-collar</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Low skilled blue-collar</td>
<td>7.5</td>
<td>7.4</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>33.1</td>
<td>33.1</td>
</tr>
<tr>
<td>Medium</td>
<td>34.1</td>
<td>35.2</td>
</tr>
<tr>
<td>Low</td>
<td>30.9</td>
<td>29.8</td>
</tr>
<tr>
<td>Other</td>
<td>1.9</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Remark: To prevent traceability of participants, exact percentages corresponding to groups N<10 are not displayed.

SD, standard deviation.
became work disabled had the highest increase in elevated blood glucose prevalence. The overall highest increase in MetS components prevalence was observed among participants who became unemployed, i.e., the individual increase in prevalence of abdominal obesity, elevated blood pressure and raised triglycerides was 5.6% or more. Only among work-disabled participants, MetS component prevalence decreased: elevated blood pressure, raised triglycerides and reduced HDL-cholesterol decreased by 3.2%, 0.8% and >0.8%, respectively.

**MetS incidence by employment transition type**
The total sample MetS incidence was 8.5% (N=1137). The highest MetS incidence was observed among participants who became work disabled (14.5%), followed by unemployment (11.4%), regular retirement (10.8%) and lastly early retirement (9.0%) (Table 3). We found the strongest association between transitioning from employment to work disability and MetS incidence in model 1 (adjusted OR 1.88; 95% CI 1.14 to 3.12), followed by unemployment (adjusted OR 1.45; 95% CI 1.10 to 1.89) and regular retirement (adjusted OR 1.35; 95% CI 1.02 to 1.79). We found no association between early retirement and MetS incidence. After adjusting for sociodemographic factors (model 2) and educational and occupational factors (model 3), associations were attenuated but remained significant among participants who became work disabled (adjusted OR 1.89; 95% CI 1.19 to 3.02) or unemployed (adjusted OR 1.39; 95% CI 1.05 to 1.82).

**Table 2**  
MetS components prevalence (%) by employment transition type at baseline (T0) and follow-up (T3) assessment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T0 T3 change T0-T3</td>
<td>T0 T3 change T0-T3</td>
<td>T0 T3 change T0-T3</td>
<td>T0 T3 change T0-T3</td>
<td>T0 T3 change T0-T3</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>28.4/31.3 +2.9</td>
<td>32.3/37.9 +5.6</td>
<td>35.5/39.5 +4.0</td>
<td>27.3/30.0 +2.7</td>
<td>29.3/33.0 +3.7</td>
</tr>
<tr>
<td>Elevated blood pressure</td>
<td>42.4/48.6 +6.2</td>
<td>45.4/51.7 +6.3</td>
<td>48.4/45.2 −3.2</td>
<td>48.4/57.4 +9.0</td>
<td>51.7/59.3 +7.6</td>
</tr>
<tr>
<td>Elevated blood glucose</td>
<td>8.2/12.1 +3.9</td>
<td>8.5/12.5 +4.0</td>
<td>&lt;8.1/14.5 +6.4</td>
<td>11.0/12.9 +1.9</td>
<td>13.4/16.4 +3.0</td>
</tr>
<tr>
<td>Raised triglycerides</td>
<td>9.7/12.1 +2.4</td>
<td>9.4/15.6 +6.2</td>
<td>16.1/15.3 −0.8</td>
<td>10.6/12.4 +1.8</td>
<td>6.7/12.5 +5.8</td>
</tr>
<tr>
<td>Reduced HDL-cholesterol</td>
<td>4.6/5.5 +0.9</td>
<td>4.2/7.4 +3.2</td>
<td>8.9/15 &lt;8.1 −&gt;0.8</td>
<td>4.7/5.7 +1.0</td>
<td>3.5/6.0 +2.5</td>
</tr>
</tbody>
</table>

**Remark:** To prevent traceability of participants, exact percentages corresponding to groups N<10 are not displayed.

HDL, high-density lipoprotein; MetS, metabolic syndrome.

**Table 3** Logistic regression - MetS incidence by employment transition type

<table>
<thead>
<tr>
<th>Employment transition type</th>
<th>N MetS/N total</th>
<th>%</th>
<th>Model 1 (OR (95% CI))</th>
<th>Model 2 (OR (95% CI))</th>
<th>Model 3 (OR (95% CI))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working control group</td>
<td>935/11 392</td>
<td>8.2</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
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<tr>
<td>Unemployment</td>
<td>63/551</td>
<td>11.4</td>
<td>1.45 (1.10 to 1.89)</td>
<td>1.43 (1.09 to 1.88)</td>
<td>1.39 (1.05 to 1.82)</td>
</tr>
<tr>
<td>Work disability</td>
<td>18/124</td>
<td>14.5</td>
<td>1.88 (1.14 to 3.12)</td>
<td>1.90 (1.47 to 2.46)</td>
<td>1.89 (1.15 to 3.10)</td>
</tr>
<tr>
<td>Early retirement</td>
<td>63/700</td>
<td>9.0</td>
<td>1.10 (0.84 to 1.44)</td>
<td>1.06 (0.80 to 1.32)</td>
<td>1.10 (0.82 to 1.47)</td>
</tr>
<tr>
<td>Regular retirement</td>
<td>58/536</td>
<td>10.8</td>
<td>1.35 (1.02 to 1.79)</td>
<td>1.28 (1.09 to 1.52)</td>
<td>1.32 (0.95 to 1.82)</td>
</tr>
<tr>
<td>Covariates</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up time, years</td>
<td></td>
<td></td>
<td>1.00 (1.00 to 1.01)</td>
<td>1.00 (1.00 to 1.01)</td>
<td>1.00 (1.00 to 1.01)</td>
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<tr>
<td>Age, years</td>
<td></td>
<td></td>
<td>1.00 (0.99 to 1.02)</td>
<td>1.00 (0.98 to 1.02)</td>
<td>1.00 (0.98 to 1.02)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Female</td>
<td>543/7064</td>
<td>7.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>594/6239</td>
<td>9.5</td>
<td>1.28 (1.13 to 1.45)</td>
<td>1.25 (1.06 to 1.47)</td>
<td>1.25 (1.06 to 1.47)</td>
</tr>
<tr>
<td>Marital status</td>
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</tr>
<tr>
<td>Married / partnered</td>
<td>1009/11 922</td>
<td>8.5</td>
<td>Ref.</td>
<td>Ref.</td>
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<tr>
<td>Not married / partnered</td>
<td>128/1381</td>
<td>9.3</td>
<td>1.16 (0.95 to 1.43)</td>
<td>1.16 (0.94 to 1.43)</td>
<td>1.16 (0.94 to 1.43)</td>
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<tr>
<td>Weekly working hours</td>
<td></td>
<td></td>
<td>1.01 (1.00 to 1.02)</td>
<td>1.01 (1.00 to 1.02)</td>
<td>1.01 (1.00 to 1.02)</td>
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<tr>
<td>Occupational group</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>High skilled white-collar</td>
<td>588/7015</td>
<td>8.4</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
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<tr>
<td>Low skilled white-collar</td>
<td>333/3966</td>
<td>8.4</td>
<td>0.91 (0.77 to 1.06)</td>
<td>0.91 (0.77 to 1.06)</td>
<td>0.91 (0.77 to 1.06)</td>
</tr>
<tr>
<td>High skilled blue-collar</td>
<td>109/1328</td>
<td>8.2</td>
<td>0.70 (0.55 to 0.89)</td>
<td>0.70 (0.55 to 0.89)</td>
<td>0.70 (0.55 to 0.89)</td>
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<tr>
<td>Low skilled blue-collar</td>
<td>107/994</td>
<td>10.8</td>
<td>1.03 (0.80 to 1.31)</td>
<td>1.03 (0.80 to 1.31)</td>
<td>1.03 (0.80 to 1.31)</td>
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<td>Educational level</td>
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</tr>
<tr>
<td>High</td>
<td>310/4399</td>
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<td>Ref.</td>
<td>Ref.</td>
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<tr>
<td>Medium</td>
<td>385/4540</td>
<td>8.5</td>
<td>1.35 (1.14 to 1.59)</td>
<td>1.35 (1.14 to 1.59)</td>
<td>1.35 (1.14 to 1.59)</td>
</tr>
<tr>
<td>Low</td>
<td>419/4116</td>
<td>10.2</td>
<td>1.64 (1.37 to 1.97)</td>
<td>1.64 (1.37 to 1.97)</td>
<td>1.64 (1.37 to 1.97)</td>
</tr>
<tr>
<td>Other</td>
<td>23/248</td>
<td>9.3</td>
<td>1.53 (0.98 to 2.40)</td>
<td>1.53 (0.98 to 2.40)</td>
<td>1.53 (0.98 to 2.40)</td>
</tr>
</tbody>
</table>

**Remark:** Model 1 is adjusted for follow-up time, model 2 is additionally adjusted for age, sex and marital status, and model 3 is additionally adjusted for weekly working hours, occupational group and educational level.

*ORs written in bold are significant (p<0.05). CI, confidence interval; MetS, metabolic syndrome; OR, odds ratio; Ref., reference group.
1.06 to 1.82), and were no longer significant among regular retirees. The interaction effect between occupational group and employment transitions on MetS incidence was not significant, i.e., no moderating role of occupational group was found.

Sensitivity analyses
The main results hold when excluding participants who have T2DM at T0 (N=34), and when including participants who work <12 hours per week at T0 (N=558).

DISCUSSION
In this 3.7-year follow-up study among 13,303 older Dutch workers, employment transition type was associated with MetS incidence. Transitioning from employment to unemployment or work disability was associated with a higher MetS incidence compared to the working control group in all tested models. Transitioning from employment to regular retirement was associated with a higher MetS incidence in model 1 only. Transitioning from employment to early retirement was not associated with MetS incidence. Occupational group did not moderate the association between employment transition types and MetS incidence.

This longitudinal study adds to the scarce literature on the association of late-career employment transition types with MetS incidence. The finding that transitioning from employment to unemployment was associated with a higher MetS incidence is in line with one previous study reporting an increased MetS incidence risk among women who became unemployed.21 No association between transitions from employment to early retirement or regular retirement and MetS incidence was found after adjusting for sociodemographic, educational and occupational factors. This is in line with one earlier study reporting no consistent effect of retirement on MetS biomarkers, and contradicts two studies reporting a significantly increased MetS or MetS components risk among retirees.1 19–21 The contradictory findings regarding early retirement and regular retirement can be explained by methodological differences. Previous studies focused either specifically on regular retirement or compared early and regular retirees to a very diverse control group.1 19–20 Our findings are not directly comparable as we simultaneously investigated the association between transitioning from employment to early retirement, regular retirement, unemployment, or work disability and MetS incidence, and included a clearly defined working control group as the reference. Regarding broader physical health outcomes, our findings are in line with studies reporting adverse health outcomes of involuntary employment transitions due to minimised financial control or an increase in unhealthy behaviours.2 9 25 The association between employment transition type and MetS incidence did not differ by occupational group membership which suggests that other factors like differences in health behaviours, underlining diseases or psychosocial working conditions might play a more important role in explaining MetS incidence differences.11 13 16 34 More research is needed as this is the first study that simultaneously compared their associations with MetS incidence to a working control group. This adds relevant information to the few existing studies which focused specifically on early or regular retirement, or unemployment.19–21 Further, the risk of information bias is limited due to the high methodological quality of the data including objectively measured MetS components.37 21 Further, the study results were robust to sensitivity analyses. Lastly, the longitudinal study design allows examining the association between employment transition type and MetS incidence. However, the results have to be interpreted with caution as information on the exact date of employment transitions and MetS incidence was unavailable.

There are some limitations. First, we might have underestimated MetS incidence and MetS components prevalence at follow-up as medication use was only recorded at baseline, and because drop-out participants were somewhat unhealthier than participants in the study sample. Although differences were small, some selection bias due to loss to follow-up is possible. Second, although some demographic underrepresentation exists in the Lifelines cohort (e.g., concerning migrants or lower educational level), the study population is broadly representative of the Northern Netherlands.24 However, the generalisability of the results to the rest of the Netherlands and other countries may be limited. Third, future research would benefit from including self-reported information about the voluntariness of the employment transitions. For instance, although transitioning into retirement is generally considered as voluntary,6 it may be involuntary when workers would like to continue working but are restricted by company regulations. Similarly, unemployment may be voluntary, for example, when workers want to switch careers and are searching for new employment opportunities.

The study results have implications for policy, practice and future research. Transitioning from employment to unemployment or work disability was associated with a higher MetS incidence among older workers. Unemployed and work disabled older workers are not reachable by workplace health promotions which makes interventions focused on health improvement possibly even more difficult.35 More awareness among occupational physicians (OPs) and GPs about MetS incidence in late working life is needed in general and more specific among older workers who transition into unemployment or work disability. Regular health check-ups carried out by OPs and GPs may help to detect MetS components before full MetS develops. Further, health behaviour change is crucial for overall MetS improvement.14 More research into the mechanisms linking employment transitions and MetS incidence is needed, such as the role of changes in health behaviours after employment transitions, which might influence MetS development.12 22 Lastly, to assess variability in employment states over time, future research would benefit from using more detailed register data.

To conclude, among a large sample of older Dutch workers, transitioning from employment to unemployment or work disability was associated with a higher MetS incidence. Transitioning from employment to early retirement or regular retirement was not associated with MetS incidence in the models adjusted for sociodemographic, educational and occupational factors. The association between employment transition type and MetS incidence did not differ by occupational group. More awareness among OPs and GPs about MetS incidence in late working life is needed in general and more specific among older workers who transition into unemployment or work disability.

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**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** The Lifelines Cohort Study is conducted according to the principles of the Declaration of Helsinki and in accordance with the research code of the University Medical Center Groningen (UMCG). The Lifelines study is approved by the medical ethical committee of the UMCG, the Netherlands (ethics number: 2007/152). Participants gave informed consent to participate in the study taking part before 2010.

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**Data availability statement** Data are available on reasonable request. Data may be obtained from a third party and are not publicly available. Researchers can apply for the data and biomaterial through a proposal that is submitted to the Lifelines research office (research@lifelines.nl).

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