Are changes in occupational physical activity level compensated by changes in exercise behavior?

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Abstract

**Background:** Physically active occupations with high energy expenditure may lead to lower motivation to exercise during leisure time, while the reverse can be hypothesized for sedentary occupations. The aim of this study was to investigate the impact of changing occupational activity level on exercise behavior.

**Methods:** Data on occupational physical activity and leisure time exercise were taken from a population-based cohort, with surveys completed in 2010 and 2014. Using data on those employed in both years, two trajectories were analyzed: 1) participants who changed from sedentary to active occupations, and 2) participants who changed from active to sedentary occupations. Exercise was reported in hours per week and changes from 2010 to 2014 were categorized as decreased, increased, or stable. Associations were expressed as odds ratios (OR) and 95% Confidence Intervals (CI) adjusting for age, gender, and education.

**Results:** Data were available for 12969 participants (57% women, aged 45±9 years, 57% highly educated). Relative to participants whose occupational activity was stable, participants who changed to active occupations (n=549) were more likely to decrease exercise (OR=1.22, CI=1.02–1.47) and those who changed to sedentary occupations (n=373) more likely to increase exercise levels (OR=1.21, CI=0.97–1.52).

**Conclusion:** People changing from sedentary to active occupations compensate by exercising less, and those changing from physically active to sedentary occupations seem to compensate by exercising more in their leisure time. When developing and evaluating interventions to reduce occupational sedentary behavior or to promote exercise, mutual influences on physical activity of different contexts should be considered.

**Key words:** physical activity, exercise, sedentary, work, job, occupation
Introduction

Physical inactivity remains the greatest public health problem of the 21st century (1) and understanding its determinants is crucial in order to design health promoting interventions.(2) Occupational activity level is important as adults who are employed full-time spend almost half of their waking time working.(3) High levels of occupational physical activity are, despite convincing evidence of health benefits of physical activity (1), not inevitably related to better cardio metabolic and musculoskeletal health.(4, 5) Sedentary occupations, on the other hand, are well-known to have negative health consequences.(6)

Occupational physical activity may influence behaviors outside working hours.(7) It can be hypothesized that physically active occupations which require high energy expenditure lead to lower motivation to be physical active during leisure time. This effect may be particularly evident for exercise, which is defined as a subset of physical activity that is planned, structured and repetitive.(8) It can similarly be hypothesized that sedentary occupations do not inhibit exercise motivation. Indeed, cross-sectional studies with small samples indicated that people with sedentary occupations exercise more during leisure time than workers with more physically active occupations.(7) However, other studies reported that people with active occupations also engaged more in exercise.(7) These inconsistent findings of previous studies could be due to different study populations (e.g., industrial employees), sample size, or study design. Moreover, other factors such as gender, age, or education may both confound and moderate the association between occupational and leisure time activity, but have seldom been addressed in previous studies.(7)

Finding the right balance between occupational activity level and exercise in leisure time is crucial to prevent an excessively inactive lifestyle.(9, 10) For people with sedentary occupations, exercising during leisure time may be an effective means of reducing musculoskeletal
morbidity.\(^{(11)}\) For people with physically active occupations, leisure time exercise might potentially still have positive health effects, but could be more challenging to achieve given the energy already needed for occupations.\(^{(5)}\) A further understanding of the influence of occupational activity levels on leisure time exercise will help to inform and tailor future interventions to promote health among working populations.\(^{(3)}\)

Using a large sample of Swedish working adults, our objective was to longitudinally investigate the impact of changing occupational activity level on exercise behavior. Two hypotheses were tested in this study: i) that people changing from sedentary to physically active occupations would decrease their leisure time exercise, and ii) that those transitioning from physically active to sedentary occupations would increase their leisure time exercise. We further explored whether the above associations were dependent on age, gender, and education.

**Methods**

**Study population**

Data from the Stockholm Public Health Cohort (SPHC), a large population-based cohort in Stockholm County, were used.\(^{(12)}\) In 2002, 2006 and 2010, population samples were randomly selected from Statistics Sweden’s Register of the total population, after stratification according to residential municipality. Every four years, participants completed similar questionnaire-based surveys on a range of demographic- and health variables. Register data from Statistics Sweden have been linked to the self-reported information. The present study was approved by the Stockholm Regional Ethical Review Board (case number: 2016/749-32).

Of the participants who completed the survey in 2010, 67% completed the follow up survey in 2014.\(^{(12)}\) Participants who reported information on exercise behavior in both 2010 (baseline)
and 2014 (follow-up) were assessed for eligibility (n=49133). Mean age of the sample assessed for eligibility was 54 years (SD=16), 57% were women and 48% highly educated. Participants were excluded if they were outside the age range of 18-60 years old at baseline (n=19733), not registered as employed or self-employed in both years (n=6545), or confined to bed on both occasions (n=26).

**Definition of variables**

*Outcome: leisure time exercise*

Leisure time exercise was assessed with the physical activity questionnaire (PAQ)\(^{(13, 14)}\), which has shown to be valid for classification into physical activity levels. A question was asked about hours of exercise per week, excluding daily walking and cycling. Participants were requested to answer on their average behavior during the past 12 months, considering the week variability and seasonality. Participants chose one of seven options ranging from hardly ever to more than 5 hours per week. For the purposes of our study, changes in exercise from 2010 to 2014 were defined as a decrease by at least one category, stable (i.e., no change in category), or increase by at least one category.

*Explanatory variable: occupational physical activity*

The PAQ question on occupational activity had 6 answer categories. Participants who responded “mainly sedentary” were categorized as having a sedentary occupation. Active occupations were defined as: mainly standing; walking mostly, lifting, carrying a little; walking mainly, lifting, carrying a lot; or heavy physical work. The remaining answer option was “sitting approximately half of the time”, which we defined as a mixed activity occupation. Participants with mixed activity occupations at either time point were excluded from the main analyses as these occupations did not fit the definition of an active or sedentary occupation\(^{(6)}\).
(n=2704 at baseline, n=3588 at follow-up, n=3568 at both). In line with the two hypotheses, two occupational trajectories were defined: i) change from sedentary to active occupations, compared with sustained sedentary occupations, and ii) change from active to sedentary occupations, compared with sustained active occupations (Figure 1).

We identified the following characteristics at baseline as potential confounders likely to influence exercise as well as change in occupation (15-17): age, gender and education, all based on registry data. Education was dichotomized into high (post-secondary education of at least one semester or more), versus low (no post-secondary education).

Data-analyses
Chi-square and t-test were used to explore differences in baseline characteristics between occupation trajectory groups, for categorical and continuous variables respectively. In order to test our hypotheses we performed binary logistic regression analyses using generalized linear models. For hypothesis 1, exercise was dichotomized into decreased exercise vs. stable or increased exercise (reference category). For hypothesis 2, exercise was dichotomized into increased exercise vs. stable or decreased exercise (reference category). We determined odds ratios (OR) and corresponding 95% confidence intervals (CI). All analyses were adjusted for age, gender and education. Furthermore, we tested whether associations were modified by age, gender and education using multiplicative interaction. To this end, we introduced in the regression models an interaction term between each of the variables above and the main explanatory variable, in addition to the main effects. Lastly, we performed sensitivity analyses studying the changes in exercise among participants that had mixed activity occupations at baseline (reported to be sitting half of the time; excluded from the main analyses). In these latter analyses people changing to active occupations or to sedentary occupations were
compared to people with mixed activity occupations in both years. The conventional level for statistical significance was set at $p$-value <0.05 for all tests. All statistical analyses were performed in IBM SPSS Statistics version 23 (Armonk, NY: IBM Corp).

**Results**

The analytic sample in this study consisted of 12969 participants. Mean age was 45 years (SD=9), 57% were women (n=7392) and 57% highly educated (n=7392). Baseline exercise levels were: 19% hardly never, 17% less than 1 hour per week, 28% 1-2 hours per week, 18% 2-3 hours per week, and 18% reported more than 3 hours per week.

Group baseline characteristics and associations with changing occupational activity level to active occupations (hypothesis 1) are described in Table 1. People who changed from sedentary to physically active occupations were more likely to be women and less likely to be highly educated compared to people with sustained sedentary occupations. Compared to those with sustained sedentary occupations, those who changed from sedentary to active occupations had higher odds to decrease exercise levels (OR=1.22, CI=1.02 – 1.47).

Group baseline characteristics and associations with changing occupational activity level to sedentary occupations (hypothesis 2) are described in Table 2. People who changed from active to sedentary occupations were on average younger and more highly educated than people with sustained active occupations. Those who changed from active to sedentary occupations had higher odds to increase exercise levels (OR=1.21, CI=0.97 – 1.52); however, the estimate did not attain the formal statistical significance.

Formal tests for interaction showed that the associations under hypothesis 1 were not modified by age (B=-0.01, CI=-0.01-0.03), gender (B=0.31, CI=-0.06-0.68), or education (B=0.18, CI=0.18-
The same was true for the associations under hypothesis 2: age B=-0.02, CI=-0.04-0.01; gender B=-0.21, CI=-0.66-0.24; education B=-0.02, CI=-0.46-0.42.

Sensitivity analyses
A total of 6272 participants had mixed-activity occupations at baseline (mean age 46 (SD=9) years, 55% women, 61% highly educated). Of this group, 1186 changed to active occupations and 1518 to sedentary occupations, while 3568 remained in the mixed-activity group at follow-up. Compared to the latter group, individuals changing to active occupations were more likely to decrease exercise (OR=1.20; CI=1.04–1.38), while those changing to sedentary occupations appeared to increase exercise, although the result was not statistically significant (OR=1.12 CI=0.98–1.28).

Discussion
To our knowledge, this is the first study examining the longitudinal interactions between occupational physical activity (or inactivity) levels and leisure time exercise in the Swedish working population. The main findings support the hypothesis that people changing from sedentary to physically active occupations seem to compensate by decreasing their leisure time exercise. The same is true for people changing from physically active to sedentary occupations, where the compensation occurs by increasing leisure time exercise. These associations were not different according to age, gender or education level. The findings were further corroborated by analyses conducted on people that reported to be sedentary at work half of the time, where the same tendency to compensation was seen among those changing to an active or sedentary occupation. Despite an overall consistent picture it should be noted that most results were of borderline statistical significance and magnitudes of index of effect sizes were small. Therefore, the results of this study should be confirmed in future research.
Our results do not support the findings of a recent systematic review, which concluded that physical activity behavior is not compensated across domains.\(^{(18)}\) Studies in this review were heterogeneous in terms of population groups and physical activity contexts, and it is plausible that compensation does not occur in all settings. For example, children who were restricted in activity during school breaks did not compensate by increasing activity after school\(^{(19)}\), and inactive adults participating in an exercise intervention did not reduce physical activity in other aspects of their daily life.\(^{(20)}\) On the other hand, a previous study focusing on occupational activity found that reducing sedentary time by introducing sit-to-stand workstations in offices was followed by reduced activity and increased sitting outside of working hours.\(^{(21)}\) It is possible that changes in work-related physical (in)activity are more prone to compensation than physical activity in other contexts because a considerable amount of time is spend at work. Future studies are necessary for a better understanding of the mechanisms of compensation across physical activity domains and its applicability in different contexts.

Associations between changes of physical activity at work and exercise outside work were not dependent on age, gender and education, despite the fact that choice of occupation and exercise levels are both known to be associated with these characteristics. For example, men are more likely to be employed in blue-collar or high manual-labor occupations than women, and highly educated persons are more likely to do desk-work.\(^{(7)}\) In addition, men and highly educated people typically show higher levels of exercise compared to women or low educated people, and women show higher levels of housework physical activity than men, which may prevent them from engaging in structured exercise activities.\(^{(2)}\)
Many physical activity interventions have been found to be ineffective.\(^{(22, 23)}\) Our results imply that when interventions do succeed in increasing physical activity or reducing sedentary behavior in one setting, there is a risk that people compensate by modifying their behavior in other contexts. For example, interventions focusing on increasing occupational physical activity should be aware that this might be compensated by decreasing leisure time physical activity and thus does not result in an overall increase in total physical activity. We recommend that researchers developing or evaluating interventions focused on behavior change in one context should also always consider this compensation as a potential side effect.

**Strengths and limitations**

The present study enhances the currently limited evidence on occupational activity change and exercise as it used a population-based longitudinal sample of large size. However, limitations of our study exist, such as possible bias due to attrition at follow-up, along with non-differential misclassification of exposures and self-reported outcomes. Self-reported information is a recognized limitation of studies with behavioral end-points. The use of objective measures to study occupational and leisure time physical activity, such as accelerometers and inclinometers combined with self-reported information, wearable cameras or GPS (global positioning system) would improve future studies, though these measures are not easily obtained from large population-based samples.\(^{(24)}\) Lastly, the current study focused only on the effects on exercise, therefore future research should investigate if compensation also takes place for light physical activity and leisure time sedentary behavior, and take into account whether physical activity guidelines are met.
Conclusions

People changing from sedentary to physically active occupations seem to compensate by exercising less, and those changing from physically active to sedentary occupations compensate by increasing exercise in their leisure time. Age, gender and education did not moderate these associations. These results contribute to our understanding on how active and sedentary behaviors in different contexts influence each other. This knowledge should be taken into consideration when developing interventions to reduce occupational sedentary behavior or when promoting exercise. Future research should move beyond an observational design, and use objective assessment of physical activity to further clarify the complex relationship between occupational activity and leisure time exercise among the working population.
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Conflicting interests

The authors declare that they have no conflicting interests.

Key points

- Finding the right balance between occupational activity and exercise in leisure time is crucial to prevent an excessive inactive lifestyle
- People changing from sedentary to physically active occupations compensate by exercising less and those changing from physically active to sedentary occupations compensate by exercising more in their leisure time.
- Interventions focused on behavior change in one context should also always consider this compensation as a potential side effect.
References


Table 1. Baseline group characteristics for changing to active occupations and estimated odds ratio of decreasing exercise

<table>
<thead>
<tr>
<th></th>
<th>Changed to active occupations</th>
<th>Sustained sedentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>549</td>
<td>6601</td>
</tr>
<tr>
<td>Age Mean (SD)</td>
<td>44 (9)</td>
<td>44 (9)</td>
</tr>
<tr>
<td>t</td>
<td>0.69</td>
<td>0.52</td>
</tr>
<tr>
<td>Gender % women</td>
<td>63</td>
<td>54</td>
</tr>
<tr>
<td>χ²</td>
<td>18.4</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Education % high</td>
<td>63</td>
<td>70</td>
</tr>
<tr>
<td>χ²</td>
<td>12.9</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Association with decreasing exercise OR (95% CI)</td>
<td>1.22 (1.02 – 1.47)⁴</td>
<td></td>
</tr>
</tbody>
</table>

⁴adjusted for age, gender and education
Table 2. Baseline group characteristics for changing to sedentary occupations and estimated odds ratio of increasing exercise

<table>
<thead>
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<th>Changed to Sedentary occupations</th>
<th>Sustained active</th>
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</thead>
<tbody>
<tr>
<td>n</td>
<td>373</td>
<td>5446</td>
</tr>
<tr>
<td>Age</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 (10)</td>
<td>45 (10)</td>
</tr>
<tr>
<td>Between-group differences</td>
<td>t=-10.11, p&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>% women</td>
<td></td>
</tr>
<tr>
<td></td>
<td>59</td>
<td>60</td>
</tr>
<tr>
<td>Between-group differences</td>
<td>X^2=0.3, p=0.59</td>
<td></td>
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<tr>
<td>Education</td>
<td>% high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>53</td>
<td>37</td>
</tr>
<tr>
<td>Between-group differences</td>
<td>X^2=40.4, p&lt;0.01</td>
<td></td>
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<tr>
<td>Association with increasing exercise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td>1.21 (0.97 – 1.52)^a</td>
<td></td>
</tr>
</tbody>
</table>

^aadjusted for age, gender and education
Figure 1. Overview of the study