Occupational Physical Activity and the Metabolic Syndrome Among Working Women: A Go Red North Dakota Study

Arupendra Mozumdar and Gary Liguori

Objective: To examine the association of metabolic syndrome (MetSyn) with occupational physical activity (OCPA) and leisure-time physical activity (LTPA) among working women. Methods: The prevalence of MetSyn was calculated for 642 working women. Self-report questionnaire was used to determine levels of OCPA and LTPA and other lifestyle factors. Biometric data were directly collected on all women. Results: No direct relationship for OCPA and the MetSyn was determined. Sufficient LTPA however, was significantly associated with lower prevalence of MetSyn. The odds of having MetSyn was significantly higher for sedentary workers with insufficient LTPA compared with those achieving sufficient LTPA. The odds for MetSyn were similar among women employed in moderately active or heavy work yet completing insufficient LTPA compared with women doing sufficient LTPA. Conclusions: For women with sedentary occupations, a sufficient amount of LTPA is essential to reduce the risk of having the MetSyn. Women in moderate to heavy working occupations may be acquiring adequate amounts of PA to avoid having the MetSyn.

Keywords: Metabolic Syndrome, leisure-time physical activity, occupational physical activity

The metabolic syndrome (MetSyn) is characterized by a set of metabolic disorders including central obesity, hypertension, dyslipidemia (low HDL cholesterol and hypertriglyceridemia), and hyperglycemia. Each abnormality independently increases the risk for cardiovascular disease (CVD) and type-2 diabetes. Earlier studies showed that most individuals with CVD often had been found with multiple risk factors. In the US adult population, the prevalence of MetSyn has been estimated at 34.4%. In a comparative study considering data from National Health and Nutrition Examination Survey (NHANES) III (1988–1994) and NHANES 1999 to 2000, it was reported that the age-adjusted prevalence of the MetSyn increased by 23.5% among women and 2.2% among men.

The cause of the MetSyn has yet to be fully understood. While previous research suggested a strong genetic influence, many epidemiological studies show that regular physical activity (PA) reduces the risk of MetSyn factors, while lack of PA increases risk. Earlier studies have demonstrated an association of the MetSyn with sedentary behaviors, including television or video viewing, and computer use outside of work or during leisure time. Given the importance of PA for reducing metabolic risk factors, various public, private, and governmental organizations have recommended minimum PA levels for achieving minimal health benefits. Meeting PA recommendations is typically achieved through participation in leisure-time physical activity (LTPA). However, only 49% of US adults meet PA recommendations, with slightly more men (50%) than women (47%) reporting meeting the recommendations.

In contemporary western societies, adults spend a large portion of each day at their worksite engaged in occupational activities. The range of occupational physical activity (OCPA) levels varies greatly, though most are relatively sedentary. It may be expected that sedentary workers will compensate for their lack of occupational PA by engaging in more LTPA, but in fact, the opposite tends to be true. This may lead to sedentary workers being more vulnerable to the MetSyn and ensuing CVD due to the lack of PA. Therefore, it appears that OCPA may play a deterministic role in the cardiovascular health of 21st century workers.

Numerous studies from around the globe have established the rather strong inverse relationship of LTPA and incidence of CVD or prevalence of MetSyn. Only a few studies have assessed the relationship of OCPA with the risk of CVD and no significant association was found in most of them. However, some recent large-scale studies have reported an association of moderate to high OCPA with the reduced risk of CVD. In addition, a meta-analysis by Oguma and Shinoda-Tagawa established a dose-response relationship of PA with reduced CVD outcome among women and concluded that even a slight increase of PA can be beneficial for inactive individuals to reduce the CVD risk.
Properly understanding the effect of PA on cardiovascular health therefore depends on the association of OCPA and LTPA and their different combinations, with the odds of having CVD. Therefore, the aims of this study were to examine the following among working women of North Dakota: (1) whether OCPA and LTPA was independently associated to the odds for having the MetSyn, and (2) how the different combinations of OCPA and LTPA affect the association.

Methods

Participants

Participants for this study were recruited from the American Heart Association’s Go Red North Dakota program conducted between 2007 and 2009 in 3 North Dakota communities (Bismarck-Mandan, Jamestown, and Fargo-Moorhead). Initially, 683 working women employed in the 3 communities (comprising about 1% of working female population) signed-up for this study. Results for this study were derived from data of a biometric screening and a behavior survey completed by 656 women. Fourteen of these women reported being either pregnant or lactating, and were excluded from the final data set, leaving 642 participants. A battery of biometric traits including anthropometric (height, weight, body mass index, waist circumference, hip circumference, and waist-hip ratio), blood pressure (systolic and diastolic blood pressure), blood lipid (total cholesterol, HDL, LDL, and triglycerides), and fasting blood glucose were measured in all women. Participants also completed a 70-item behavior survey. The survey consisted of questions related to demography, cardiovascular fitness, dietary habit, physical activity, smoking habit, and behaviors related to management of blood pressure, cholesterol, and blood glucose. All participants signed a consent form in compliance with the Institutional Review Board of North Dakota State University, Fargo, ND.

Data collection

All biometric data for this study were collected by skilled technicians contracted through the local health care provider network. Height and weight were measured with participants wearing light clothing and without shoes. Body mass index (BMI) was calculated using the following formula: weight in kg/ height in m2. The waist circumference of the participants was measured at immediately above the iliac crest as defined by the National Cholesterol Education Program (NCEP)—Adult Treatment Panel III (ATPIII) guidelines. Blood pressure was measured after sitting quietly for at least 10 min. Participants fasted overnight (at least 8 hours) before collection of blood for the assessment of blood lipids and glucose. The blood was collected via finger prick, to minimize pain and discomfort, using a sterile needle for each participant. Lipid and glucose values were generated by a Cholestec dry auto-analyzer.

Data on OCPA was collected through the survey, which asked participants to choose among a set of statements which best described their usual daily activity at work. The options were 1) you sit during the day and do not walk very much, 2) you stand or walk quite a lot during the day, but do not have to carry or lift things very often, and 3) you do heavy work, lift or carry loads, or have to climb stairs often. This question was taken from the National Health and Nutrition Examination Survey (NHANES) and has been shown to produce valid and reliable estimates of OCPA. To measure LTPA, questions from the Behavioral Risk Factor Surveillance System (BRFSS) were modified. Data on LTPA were collected by asking ‘how often in the past 7 days did you engage in vigorous to moderate physical activities which resulted in an increase in breathing or heart rate?’ Participants were then asked to report the gross duration of such activities. Participants completing 20 minutes or more vigorous activity on at least 3 days/week, or 30 minutes or more moderate activity on at least 5 days/week, were categorized as ‘active.’ While those reporting fewer than these days/week and duration were considered ‘nonactive.’

Data analysis

Identification of MetSyn. The women with MetSyn were identified according to the modified American Heart Association/NCEP—ATPIII recommendations, by the presence of at least 3 or more of the following abnormalities for women: waist circumference > 88 cm (~35 inches), triglycerides ≥ 150 mg/dL, HDL cholesterol ≤ 50 mg/dL, blood pressure ≥ 130/85 mmHg or treatment with blood pressure-lowering medications, and fasting blood glucose ≥ 100 mg/dL or treatment for diabetes.

Statistical analysis. The participants were categorized into 3 OCPA groups, 1) sedentary (work in sitting position for whole day), 2) moderately active (work mostly in standing position or walking), and 3) heavy working (mostly perform heavy work like carrying loads and frequently climbing up and down stairs). The background characteristics (demographic characteristics, alcohol consumption, vegetable intake, physical activity level, and medication use) of the participants in each of the 3 OCPA groups was presented, and one-way ANOVA or chi-square tests of independence determined the association of background characteristics of the participants and their OCPA level. Descriptive statistics of all anthropometric and cardiovascular traits for each OCPA group were calculated. One-way ANOVA was calculated for each anthropometric and cardiovascular trait according to OCPA group. The participants were then categorized into ‘nonactive’ and ‘active’ groups based on their LTPA status. Within each LTPA group the participants were further categorized based on their OCPA group. The distribution of presence or absence of different CVD risk factors within each subgroup was presented. Moreover, the frequency distributions of prevalence of the MetSyn factors across
the 6 subgroups were also presented. The chi-square tests examined the distribution of each CVD risk factor and the frequency distribution of MetSyn factors across 6 subgroups of PA. Further post hoc analyses were done to determine in which subgroup the distribution of CVD risk factors and MetSyn factors significantly different from the expected counts.

Logistic regressions analyses were done to examine the relationship between OCPA with MetSyn. For this analysis, the outcome variable was defined as presence of MetSyn. Four models of logistic regression were calculated and the odds ratio and 95% confidence intervals were presented for all 4 models. The first model was a univariate model, where the only independent variable was OCPA with ‘heavy working’ group as the referent category. The next 3 models were multivariate models and the confounding variables—age (in Model 2), household income, education status (in Model 3), alcohol consumption, and vegetable intake (in Model 4) were subsequently added. The same analyses were conducted for examining the relationship between LTPA and MetSyn with the ‘active’ group as referent category. The confounding variables that showed significant association in the previous 2 analyses were added in all subsequent analyses.

Multivariate logistic regression analyses were done putting both OCPA and LTPA as co-variate to examine their relationship with MetSyn controlled for the effect of each other. The possible existence of a dose response relationship of PA and MetSyn were also examined. In the analysis, presence of MetSyn was the dependent variable and the independent variable was the 6 PA groups formed by classification of OCPA and LTPA. Among the 6 PA groups, the nonactive group of sedentary workers was considered doing minimum PA, whereas the active LTPA/ heavy working OCPA group was considered achieving maximum PA. Therefore, the active members of heavy working groups was considered as referent group in the analysis and the odds for having MetSyn were compared with the other 5 PA groups.

The relationship of OCPA and MetSyn were further examined, separated for 2 LTPA groups (nonactive and active) by calculating logistic regressions. The opposite analyses [ie, the relationship of LTPA and MetSyn separated for 3 OCPA groups (sedentary, moderately active and heavy working)] were also conducted. Significance level for all analyses was set at $P < .05$. All statistical analyses were done using SPSS for windows (Version 16.0) software.

### Results

The background characteristics of the participants were presented in Table 1 based on their OCPA groups. In general, the participants were middle aged women with an age range of 35 to 55 years. The result showed that the women in the ‘sedentary’ group were significantly younger than those in the ‘moderately active’ OCPA group. In all 3 OCPA groups, nearly 98% of the participants reported their ethnic background as White, with Hispanic/ Latino, Native American, Asian, and African American comprising the remaining 2% of the sample population. Nearly half of the participants belonged to the middle-income group with annual household income of $35,000–$75,000. Only 3.7% reported an annual household income over $150,000, while ~13% reported an annual household income below $35,000. About 23% of the participants completed high school only, 62% had a 4-year college degree, and 16% studied for graduate degrees. About 81% of the participants reported being either married or cohabiting, 10% were divorced or separated, and 9% were unmarried. Nearly half of the participants consumed 1 to 2 alcoholic drinks weekly. More than half (~60%) of the study participants reported consuming vegetables more than 3 times per week. No significant difference was determined among the 3 groups for weekly average time spent in vigorous LTPA. However, the sedentary workers reported significantly less average time spent in moderate LTPA than the heavy working group. Less than half (~40%) of the women in the ‘sedentary’ and ‘moderately active’ groups reported engaging in the recommended level of LTPA at a vigorous to moderate level (ie, vigorous activity for 3 days/ week or moderate activity for 5 days/ week). Nearly 51% of the ‘hard working’ group of women engaged in recommended level of LTPA. Few women reported taking medication to manage blood pressure, blood lipids, or type-2 diabetes. Demographic characteristics for the women, regardless of OCPA, were similar except for marital status.

The descriptive statistics of age, all anthropometric, blood pressure, blood lipid, and blood glucose traits of the participants are presented in Table 2, separated by OCPA. Table 2 also shows the calculated scores of BMI and waist-hip ratio for the 3 OCPA groups. In general, the women were overweight, and had normal blood pressure, glucose, and lipid values. The results from the one-way ANOVA did not show a significant difference for any of the measurements or calculated scores among the 3 OCPA groups.

The participants were categorized into ‘nonactive’ and ‘active’ groups based on their LTPA status. Then the participants were further categorized based on their OCPA group within each LTPA groups. The presence or absence of different CVD risk factors among participants grouped by their LTPA and OCPA are presented in Table 3. Chi-square test of independence was calculated for each CVD risk factor to examine the difference in distribution of CVD risk factors across the 6 subgroups. Significant differences in the prevalence of metabolic risk factors were reported for overweight (BMI $\geq 25$ Kg/M$^2$), central obesity (waist circumference $\geq 88$ cm), high fasting blood glucose (fasting blood glucose $\geq 100$ mg/dL), and the presence of the MetSyn. The results of the post hoc analyses showed that the absence of elevated BMI was significantly lower in nonactive sedentary group. The nonactive sedentary group also had a significantly higher prevalence of central obesity and MetSyn. Although the
Table 1  Background Characteristics of Participants Grouped by Their Occupational Physical Activity Group (OCPA)

<table>
<thead>
<tr>
<th>OCPA</th>
<th>Sedentary n = 339</th>
<th>Moderately active n = 230</th>
<th>Heavy working n = 73</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y, mean (SD)</td>
<td>41.94 (10.16)*</td>
<td>44.94 (10.12)*</td>
<td>43.55 (12.24)</td>
<td>0.003</td>
</tr>
<tr>
<td>Ethnicity, %</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>White</td>
<td>98.2</td>
<td>99.1</td>
<td>97.3</td>
<td></td>
</tr>
<tr>
<td>Hispanic-Latino</td>
<td>0.9</td>
<td>–</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>–</td>
<td>–</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td>0.9</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>–</td>
<td>0.9</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Annual household income, $, %</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>&lt;10,000</td>
<td>0.3</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>10,000–14,999</td>
<td>0.3</td>
<td>0.5</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>15,000–24,999</td>
<td>5.7</td>
<td>3.3</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>25,000–34,999</td>
<td>6.3</td>
<td>8.4</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>35,000–49,999</td>
<td>13.2</td>
<td>14.0</td>
<td>20.3</td>
<td></td>
</tr>
<tr>
<td>50,000–74,999</td>
<td>32.8</td>
<td>31.6</td>
<td>29.0</td>
<td></td>
</tr>
<tr>
<td>75,000–99,999</td>
<td>22.4</td>
<td>21.4</td>
<td>20.3</td>
<td></td>
</tr>
<tr>
<td>100,000–149,999</td>
<td>14.5</td>
<td>17.2</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>150,000–199,999</td>
<td>2.2</td>
<td>3.3</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>≥200,000</td>
<td>2.2</td>
<td>0.5</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Education, %</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>&lt; High school graduate</td>
<td>2.9</td>
<td>4.0</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>High school graduate</td>
<td>16.6</td>
<td>19.2</td>
<td>28.6</td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>11.4</td>
<td>8.5</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>2 y college graduate</td>
<td>16.0</td>
<td>15.6</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td>4 y college graduate</td>
<td>41.6</td>
<td>32.1</td>
<td>30.0</td>
<td></td>
</tr>
<tr>
<td>Graduate education</td>
<td>11.7</td>
<td>20.5</td>
<td>17.1</td>
<td></td>
</tr>
<tr>
<td>Marital status, %</td>
<td></td>
<td></td>
<td></td>
<td>0.027</td>
</tr>
<tr>
<td>Single/unmarried</td>
<td>11.5</td>
<td>6.1</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>Married/cohabiting</td>
<td>78.8</td>
<td>82.2</td>
<td>69.9</td>
<td></td>
</tr>
<tr>
<td>Divorced/separated</td>
<td>8.3</td>
<td>10.4</td>
<td>13.7</td>
<td></td>
</tr>
<tr>
<td>Widow</td>
<td>0.3</td>
<td>–</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>Not answered</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Alcohol consumption/week, %</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>None</td>
<td>19.8</td>
<td>21.3</td>
<td>23.3</td>
<td></td>
</tr>
<tr>
<td>1–2 drinks</td>
<td>49.0</td>
<td>46.5</td>
<td>49.3</td>
<td></td>
</tr>
<tr>
<td>3–4 drinks</td>
<td>16.8</td>
<td>15.7</td>
<td>15.1</td>
<td></td>
</tr>
<tr>
<td>5 and more drinks</td>
<td>14.5</td>
<td>16.5</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>Vegetable intake/ week, %</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>None</td>
<td>4.4</td>
<td>3.0</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>1–2 times</td>
<td>31.0</td>
<td>23.0</td>
<td>32.9</td>
<td></td>
</tr>
<tr>
<td>3–4 times</td>
<td>29.5</td>
<td>38.3</td>
<td>35.6</td>
<td></td>
</tr>
<tr>
<td>5 and more times</td>
<td>35.1</td>
<td>35.7</td>
<td>27.4</td>
<td></td>
</tr>
<tr>
<td>Physical activity (PA), min/week, mean (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>53.41 (85.34)</td>
<td>61.67 (82.28)</td>
<td>72.68 (82.51)</td>
<td>NS</td>
</tr>
<tr>
<td>Moderate activity</td>
<td>85.36(103.15)*</td>
<td>89.57 (76.39)</td>
<td>118.64(115.59)*</td>
<td>0.030</td>
</tr>
<tr>
<td>PA, %</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Recommended level of PA (Vigorous PA for 3 days/Moderate PA for 5 days)</td>
<td>40.4</td>
<td>42.6</td>
<td>50.7</td>
<td></td>
</tr>
<tr>
<td>Medication use, %</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>For high blood pressure</td>
<td>13.9</td>
<td>14.3</td>
<td>13.7</td>
<td></td>
</tr>
<tr>
<td>For high blood lipid</td>
<td>9.4</td>
<td>11.7</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>Oral glucose pill</td>
<td>1.8</td>
<td>2.2</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Insulin intake</td>
<td>0.6</td>
<td>1.3</td>
<td>2.7</td>
<td></td>
</tr>
</tbody>
</table>

* Post hoc analyses revealed significant difference.
prevalence of high fasting blood glucose showed a significant association with the distribution of participants based on their LTPA and OCPA, the post hoc analyses did not show any significant difference from the expected counts for any of the 6 subgroups.

The frequency distribution of prevalence of MetSyn factors in each of the 6 subgroups is presented also in Table 3. The result of chi-square test of independence showed a significant difference in the frequency distributions of MetSyn factors across the 6 subgroups. The post hoc analysis revealed that the nonactive sedentary group had a significantly lower percent of participants without a MetSyn factor. Moreover, the same group also had a significantly higher frequency of participants with 4 MetSyn factors. The nonactive (for LTPA) moderately active (for OCPA) group had a significantly higher frequency of participants with 5 MetSyn factors.

The results of logistic regression analyses to examine the relationship between OCPA and MetSyn are presented in Table 4. None of the 4 logistic regression models revealed a significant relationship between MetSyn and OCPA. Among the other confounding variables, age and annual household income showed a significant relationship with MetSyn. Although the crude odds ratio (in Model 1) for prevalence of MetSyn in the sedentary group was lower than the heavy working group, the adjusted odds ratios were higher after adjusting for age (in Model 2 to 4). This was likely due to the lower mean age of the sedentary workers. In Table 5, the results of logistic regression analyses are presented to examine the relationship between LTPA and MetSyn. The nonactive group showed a significantly higher crude odds ratio (in Model 1) as well as the adjusted odds ratios (in Model 2 to 4) compared with the active group for the presence of MetSyn. Among the confounding variables, age and annual household income showed a significant contribution in the logistic regression models (Models 2 to 4). Therefore, in the following analyses only these 2 factors were added as confounding variables.

Results of the multivariate logistic regression analyses to quantify the association of MetSyn with both OCPA and LTPA as covariates are presented in Table 6. Three models of multiple logistic regression were calculated. The first one had 2 covariates [ie, OCPA (with ‘heavy working’ as referent) and LTPA (with ‘active’ group as referent)]. Age (in Model 2) and annual household income (Model 3) were subsequently added in the other 2 models. The results did not show any significant association of OCPA for any of the logistic regression models. However, significantly higher adjusted odds ratios for the nonactive LPTA group were reported in all 3 models even after adding the confounding variables. Table 6 also presents the logistic regression analysis for examining the possible dose response relationship between PA and MetSyn using active members of heavy working group as the referent group. The results did not show any significant dose response relationship for PA and MetSyn even after controlling for significant confounding variables.

### Table 2: Descriptive Statistics of All Anthropometric, Blood Pressure, Blood Lipid, and Fasting Blood Glucose of the Participants Separated by Occupational Physical Activity Group (OCPA)

<table>
<thead>
<tr>
<th>OCPA</th>
<th>Sedentary (n = 339)</th>
<th>Moderately active (n = 230)</th>
<th>Heavy working (n = 73)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>171.45 ± 39.32</td>
<td>166.39 ± 35.97</td>
<td>164.35 ± 42.20</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>64.95 ± 2.56</td>
<td>64.85 ± 2.55</td>
<td>64.76 ± 2.64</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.60 ± 6.53</td>
<td>27.63 ± 5.73</td>
<td>27.57 ± 6.92</td>
</tr>
<tr>
<td>Waist circumf. (cm)</td>
<td>35.00 ± 5.92</td>
<td>34.56 ± 5.44</td>
<td>34.47 ± 6.21</td>
</tr>
<tr>
<td>Hip circumf. (cm)</td>
<td>42.68 ± 5.42</td>
<td>42.20 ± 4.96</td>
<td>41.98 ± 5.61</td>
</tr>
<tr>
<td>Waist-Hip ratio</td>
<td>0.82 ± 0.06</td>
<td>0.82 ± 0.05</td>
<td>0.82 ± 0.06</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>123.53 ± 14.62</td>
<td>122.66 ± 14.33</td>
<td>120.12 ± 17.60</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>76.00 ± 9.43</td>
<td>76.47 ± 9.99</td>
<td>73.63 ± 9.89</td>
</tr>
<tr>
<td>Total Cholesterol (mg/dL)</td>
<td>189.83 ± 32.72</td>
<td>193.05 ± 33.22</td>
<td>192.70 ± 30.81</td>
</tr>
<tr>
<td>HDL Cholesterol (mg/dL)</td>
<td>55.85 ± 13.72</td>
<td>57.91 ± 13.88</td>
<td>56.08 ± 13.12</td>
</tr>
<tr>
<td>LDL Cholesterol (mg/dL)</td>
<td>109.18 ± 28.37</td>
<td>109.68 ± 30.66</td>
<td>111.66 ± 25.87</td>
</tr>
<tr>
<td>Total/HDL Cholesterol</td>
<td>3.60 ± 1.15</td>
<td>3.55 ± 1.20</td>
<td>3.60 ± 0.98</td>
</tr>
<tr>
<td>LDL/HDL Cholesterol</td>
<td>2.08 ± 0.81</td>
<td>2.06 ± 0.99</td>
<td>2.10 ± 0.75</td>
</tr>
<tr>
<td>Triglycerides (mg/dL)</td>
<td>133.13 ± 80.70</td>
<td>129.22 ± 64.36</td>
<td>126.89 ± 65.01</td>
</tr>
<tr>
<td>FBG (mg/dL)</td>
<td>89.81 ± 14.55</td>
<td>89.86 ± 16.99</td>
<td>89.35 ± 31.11</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, Body mass index; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; HDL, High density lipoprotein; LDL, Low density lipoprotein; FBG, Fasting blood glucose.
### Table 3  Prevalence of Different Cardiovascular Disease (CVD) Risk Factors and Frequency Distribution of Metabolic Syndrome Factors Among the Participants Grouped by Leisure-Time Physical Activity (LTPA) and Occupational Physical Activity (OCPA) and Comparison

<table>
<thead>
<tr>
<th>CVD risk factors, %</th>
<th>LTPA Nonactive</th>
<th>OCPA</th>
<th>LTPA Active</th>
<th>OCPA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sedentary n = 202</td>
<td></td>
<td>Moderately active n = 132</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-ve</td>
<td>+ve</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>BMI ≥ 25 Kg/M²</td>
<td>26.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>73.8</td>
<td>33.3</td>
<td>66.7</td>
</tr>
<tr>
<td>WC ≥ 88 cm</td>
<td>45.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>55.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>50.8</td>
<td>49.2</td>
</tr>
<tr>
<td>WHR &gt; 0.85</td>
<td>67.7</td>
<td>32.3</td>
<td>71.2</td>
<td>28.8</td>
</tr>
<tr>
<td>BP ≥ 130/85 mm-Hg</td>
<td>61.9</td>
<td>38.1</td>
<td>61.4</td>
<td>38.6</td>
</tr>
<tr>
<td>TC ≥ 200 mg/dL</td>
<td>60.9</td>
<td>39.1</td>
<td>59.8</td>
<td>40.2</td>
</tr>
<tr>
<td>HDL &lt; 50 mg/dL</td>
<td>62.4</td>
<td>37.6</td>
<td>70.5</td>
<td>29.5</td>
</tr>
<tr>
<td>Trig. ≥ 150 mg/dL</td>
<td>72.8</td>
<td>27.2</td>
<td>71.2</td>
<td>28.8</td>
</tr>
<tr>
<td>FBG ≥ 100 mg/dL</td>
<td>79.8</td>
<td>20.8</td>
<td>82.6</td>
<td>17.4</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>67.8</td>
<td>32.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>75.0</td>
<td>25.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prevalence of metabolic syndrome factors, %</th>
<th>P (Chi²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.003</td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: –ve, absence of the risk factor; +ve, presence of the risk factor; BMI, Body mass index; WC, Waist circumference; BP, Blood pressure; TC, Total cholesterol; HDL, High density lipoprotein; Trig., Triglycerides; FBG, Fasting blood glucose.

<sup>a</sup>Post hoc test revealed significantly lower count than expected.

<sup>b</sup>Post hoc test revealed significantly higher count than expected.
### Table 4  Logistic Regression Analyses of the Relationship of Metabolic Syndrome and Occupational Physical Activity (OCPA)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories/units</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCPA</td>
<td>Sedentary</td>
<td>0.96 (0.54-1.69)</td>
<td>1.05 (0.58-1.89)</td>
<td>1.28 (0.69-2.36)</td>
<td>1.31 (0.71-2.44)</td>
</tr>
<tr>
<td></td>
<td>Moderately active</td>
<td>0.72 (0.39-1.31)</td>
<td>0.68 (0.37-1.26)</td>
<td>0.80 (0.42-1.52)</td>
<td>0.78 (0.41-1.50)</td>
</tr>
<tr>
<td></td>
<td>Heavy working</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Age</td>
<td>Years</td>
<td>1.05 (1.03-1.07)</td>
<td>1.04 (1.03-1.07)</td>
<td>1.04 (1.03-1.07)</td>
<td>Ref.</td>
</tr>
<tr>
<td>Income</td>
<td>Annual household, $</td>
<td>0.994 (0.988-0.999)</td>
<td>0.994 (0.988-0.999)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Education</td>
<td>High school grad.</td>
<td>1.40 (0.87-2.25)</td>
<td>1.39 (0.86-2.25)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td></td>
<td>Some college</td>
<td>1.24 (0.79-1.96)</td>
<td>1.26 (0.79-1.99)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Yes</td>
<td>1.25 (0.80-1.96)</td>
<td>1.25 (0.80-1.96)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Consumption</td>
<td>No</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Vegetable intake/week</td>
<td>Less than 3 times</td>
<td>0.93 (0.58-1.51)</td>
<td>0.93 (0.58-1.51)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td></td>
<td>3–4 times</td>
<td>1.35 (0.86-2.13)</td>
<td>1.35 (0.86-2.13)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td></td>
<td>5 times and more</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
</tbody>
</table>

Note. Model 1 unadjusted model, Model 2 adjusted for age, Model 3 further adjusted for household income and education level, Model 4 further adjusted for alcohol consumption and vegetable intake. Results in bold denote a significant association.

### Table 5  Logistic Regression Analyses of the Relationship of Metabolic Syndrome and Leisure-Time Physical Activity (LTPA)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories/units</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTPA</td>
<td>Non-Active</td>
<td>1.93 (1.32-2.82)</td>
<td>1.96 (1.33-2.88)</td>
<td>1.85 (1.25-2.75)</td>
<td>1.87 (1.26-2.76)</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Age</td>
<td>Years</td>
<td>1.05 (1.03-1.06)</td>
<td>1.04 (1.02-1.06)</td>
<td>1.04 (1.02-1.06)</td>
<td>Ref.</td>
</tr>
<tr>
<td>Income</td>
<td>Annual household, $</td>
<td>0.994 (0.988-0.999)</td>
<td>0.994 (0.988-0.999)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Education</td>
<td>High school grad.</td>
<td>1.31 (0.82-2.11)</td>
<td>1.34 (0.83-2.11)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td></td>
<td>Some college</td>
<td>1.21 (0.76-1.91)</td>
<td>1.22 (0.76-1.94)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Yes</td>
<td>1.24 (0.79-1.92)</td>
<td>1.24 (0.79-1.92)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Consumption</td>
<td>No</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Vegetable intake/week</td>
<td>less than 3 times</td>
<td>0.92 (0.57-1.49)</td>
<td>0.92 (0.57-1.49)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td></td>
<td>3–4 times</td>
<td>1.26 (0.81-1.99)</td>
<td>1.26 (0.81-1.99)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td></td>
<td>5 times and more</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
</tbody>
</table>

Note. Model 1 unadjusted model, Model 2 adjusted for age, Model 3 further adjusted for household income and education level, Model 4 further adjusted for alcohol consumption and vegetable intake. Results in bold denote a significant association.
Table 6  Logistic Regression Analyses of the Relationship of Metabolic Syndrome With Occupational Physical Activity (OCPA) and Leisure-Time Physical Activity (LTPA) by Using Both OCPA and LPTA as Covariates and by Using the Dose Response Analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories/units</th>
<th>Odds ratios (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>OCPA</td>
<td>Sedentary</td>
<td>0.90 (0.50-1.59)</td>
</tr>
<tr>
<td></td>
<td>Moderately active</td>
<td>0.68 (0.37-1.25)</td>
</tr>
<tr>
<td></td>
<td>Heavy working</td>
<td>Ref.</td>
</tr>
<tr>
<td>LTPA</td>
<td>Non-Active</td>
<td>1.94 (1.32-2.85)</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td>Ref.</td>
</tr>
<tr>
<td>Age</td>
<td>Years</td>
<td>1.05(1.03-1.07)</td>
</tr>
<tr>
<td>Income</td>
<td>Annual household, $</td>
<td></td>
</tr>
<tr>
<td>OCPA &amp; LTPA</td>
<td>Sedentary &amp; nonactive</td>
<td>1.72(0.75-3.97)</td>
</tr>
<tr>
<td></td>
<td>Moderately active &amp; nonactive</td>
<td>1.21(0.50-2.90)</td>
</tr>
<tr>
<td></td>
<td>Heavy working &amp; nonactive</td>
<td>1.81(0.64-5.16)</td>
</tr>
<tr>
<td></td>
<td>Sedentary &amp; active</td>
<td>0.81(0.33-1.98)</td>
</tr>
<tr>
<td></td>
<td>Moderately active &amp; active</td>
<td>0.71(0.27-1.82)</td>
</tr>
<tr>
<td></td>
<td>Heavy working &amp; active</td>
<td>Ref.</td>
</tr>
<tr>
<td>Age</td>
<td>Years</td>
<td>1.05(1.03-1.07)</td>
</tr>
<tr>
<td>Income</td>
<td>Annual household, $</td>
<td></td>
</tr>
</tbody>
</table>

Note. Model 1 unadjusted model, Model 2 adjusted for age, Model 3 further adjusted for annual household income. Results in bold denote a significant association.

The relationship of OCPA and MetSyn were further examined separated for 2 LTPA groups (nonactive and active) by calculating logistic regressions and the results are presented in Table 7. Of the 3 logistic regression models Model 1 was univariate and Models 2 and 3 included age and annual household income, respectively, as confounding variables. The results did not show any significant relationship between OCPA and the MetSyn in any of the 2 LTPA groups.

In Table 8, the results of logistic regression analyses are presented to examine the relationship of LTPA and the MetSyn separated for 3 OCPA groups (sedentary, moderately active and heavy working). As in Table 7, Model 1 was a univariate analysis and Models 2 and 3 included age and annual household income, respectively. The results for all 3 models showed significantly higher odds ratios for the presence of MetSyn in the nonactive LTPA group compared with the active LTPA group, however, only for the sedentary OCPA group. Participants in the moderately active and heavy working group did not show any significant association between LTPA and presence of MetSyn in any of the 3 logistic regression models.

Discussion

The purpose of the study was to examine the relationship of the MetSyn with the levels of OCPA and LTPA among a sample of middle-aged working women in North Dakota. The status of the MetSyn for each participant was calculated using the protocol proposed by the updated AHA/NCEP ATP III. Most of the background characteristics of the participants were similar across OCPA groups. Descriptive statistics of the cardiovascular traits show that the participants were generally young and healthy, which may weaken the effect OCPA has on their cardiovascular health. The absence of any significant difference in cardiovascular traits across the 3 OCPA groups appears to validate this assumption.

The effects of OCPA and LTPA on the MetSyn were further examined by calculating the prevalence of CVD factors and the frequency distribution of MetSyn factors across the LTPA and OCPA groups. The ‘nonactive’ participants in the sedentary group showed a high prevalence of CVD risk factors including the presence of MetSyn, while at the same time had the lowest prevalence of participants without any MetSyn factors. The results of logistic regression analyses revealed that OCPA alone or even controlled for LTPA did not have a significant relationship with the MetSyn, whereas, LTPA had a significant association with the MetSyn even after controlling for OCPA and other confounding variables. No dose response relationship was reported for PA levels and the MetSyn.

Nonactive LTPA participants showed consistently higher odds for the presence of MetSyn across all OCPA groups, though the results were only significant for women in sedentary occupations with low LTPA, compared with the active participants. Therefore, it can
### Table 7 Logistic Regression Analyses of the Relationship of Metabolic Syndrome and Occupational Physical Activity (OCPA) Separated for the Participants in Leisure-Time Physical Activity (LTPA) Groups

<table>
<thead>
<tr>
<th>OCPA</th>
<th>Nonactive (n = 370), OR (95% CI)</th>
<th>LTPA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Sedentary</td>
<td>0.95 (0.45-2.02)</td>
<td>1.10 (0.50-2.41)</td>
</tr>
<tr>
<td>Moderately active</td>
<td>0.67 (0.30-1.48)</td>
<td>0.70 (0.31-1.60)</td>
</tr>
</tbody>
</table>

Abbreviations: OR, Odds Ratio; CI, confidence interval.

Note. Model 1 unadjusted model, Model 2 adjusted for age, Model 3 further adjusted for household income.

### Table 8 Logistic Regression Analyses of the Relationship of Metabolic Syndrome and Leisure-Time Physical Activity (LTPA) Separated for the Participants in Occupational Physical Activity (OCPA) Groups

<table>
<thead>
<tr>
<th>LTPA</th>
<th>Sedentary (n = 339), OR (95% CI)</th>
<th>Moderately active (n = 230), OR (95% CI)</th>
<th>Heavy working (n = 73), OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
</tr>
<tr>
<td>Nonactive</td>
<td>2.13 (1.26-3.59)</td>
<td>2.05 (1.21-3.50)</td>
<td>2.01 (1.18-3.44)</td>
</tr>
</tbody>
</table>

Abbreviations: OR, Odds Ratio; CI, confidence interval.

Note. Model 1 unadjusted model, Model 2 adjusted for age, Model 3 further adjusted for household income. Results in bold denote a significant association.
be inferred that moderately active and heavy working occupations, regardless of LTPA, confer some physical activity benefits toward the prevention of the MetSyn, unlike sedentary workers doing little or no LTPA.

The results of this study corroborate with the findings of earlier studies where no direct association was determined for CVD risk with occupational physical activity.\textsuperscript{26,27} In the current study, the relationship of LTPA and MetSyn was described, and the finding was similar to what had been previously reported.\textsuperscript{15,16,17,20–23} No dose-response relationship between the combination of PA and MetSyn was reported in this study, however, which was not consistent with previous studies.\textsuperscript{28,30} The finding of this study however, suggest the beneficial effect of moderate or heavy OCPA may attenuate the risk of CVD, which agrees with the finding of an earlier study on a population of similar ethnic background.\textsuperscript{29} However, the finding of this study contrasts with Sabchez-Chaparro et al.,\textsuperscript{34} who found in a cross sectional study of Spanish workers, a higher prevalence of MetSyn in blue collar workers that had a greater emphasis on OCPA, compared with more sedentary white collar workers.

A potential limitation of our study is the self-report of PA. Self-administered questionnaires are relatively crude and imprecise measures of habitual PA, smoking, socioeconomic factors, alcohol consumption, medication use, and medical history. A recent study by Troiano et al reported that the respondents of a PA survey using a self-reported method greatly overestimate their PA. Moreover, the overestimation of PA could affect both total PA levels and PA duration.\textsuperscript{35} However, the LTPA questions used herein were taken from the BRFSS, and the OCPA question is from NHANES, which are so far the most widely used and reliable questionnaires. Finally, the scope of the findings for this study is limited to a small sample of working women who are predominately White.

In conclusion, the study revealed that unlike OCPA, the lack of sufficient LTPA had a prominent relationship with the presence of MetSyn among working women. Sufficient LTPA appeared to be critical in avoiding MetSyn for women in sedentary occupations. However, the odds for having MetSyn were similar for nonactive LTPA and nonactive OCPA; moderately active and nonactive LTPA heavy working OCPA women as it was for those women who were active in LTPA. Therefore, the MetSyn may be minimized for women in moderately active and heavy-working occupations, regardless of their LTPA. Similar studies on larger samples with more diverse ethnic groups would be helpful to draw more definitive conclusion.

References


