Expenditure on Health Care in Obese Women with and without Sleep Apnea

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Study Objectives: To determine the effect of obesity and sleep apnea on health care expenditure in women over 10 years.

Design: Retrospective observational study

Setting: Tertiary university-based medical center

Patients and controls: Three groups of age-matched women: 223 obese women with OSAS (body mass index: 39.3 ± 0.6 kg/m²), and from the general population, 223 obese controls (BMI 36.3 ± 0.4) and 223 normal weight controls (BMI 23.9 ± 0.4).

Interventions: None

Measurements and Results: We examined health care utilization in the 3 matched groups for the 10 years leading up to the documentation of OSAS. The mean physician fees and the number of physician visits were significantly higher in obese controls than in normal weight controls during the observed period. Physician fees and physician visits progressively increased in the 10 years before diagnosis in the OSAS cases and were significantly higher than in the matched obese controls. Physician fees, in Canadian dollars, one year before diagnosis in the OSAS cases were higher than in obese controls: $547.49 ± 34.79 vs $246.85 ± 20.88 (P < 0.0001). More was spent for OSAS cases on physician fees for circulatory, endocrine and metabolic diseases, and mental disorders than the obese controls. Physician visits one year before diagnosis in the OSAS cases were more frequent than in the obese controls: 13.2 ± 0.73 visits vs 7.26 ± 0.49 visits (P < 0.0001).

Conclusions: Obese women are heavier users of health services than normal weight controls. Obese women with OSAS use significantly more health services than obese controls. Since OSAS imposes a greater financial burden, treatment of OSAS may reduce other comorbidities and lower overall medical costs.

Keywords: Obesity, obstructive sleep apnea, female, medical economics, health services

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METHODS

This study was conducted in the Canadian Province of Manitoba. Surrogates of health care utilization, physician fees, and physician visits were investigated in three groups: obese women, normal weight women, and obese women with OSAS by using the Manitoba Health database. Obese women with OSAS were selected first, and then 2 control groups were randomly selected by matching those with OSAS based on the severity of obesity (see below).

The Manitoba Health database, described in detail elsewhere, allows longitudinal tracking of the health care utilization of individuals and their diagnoses based on the International Classification of Disease (ICD-9) codes. All residents of Manitoba have unrestricted access to government-funded health care services, including physician services and hospitalizations. When physicians see a patient, a standardized claim is submitted to the government agency responsible (Manitoba Health), which then renders payment (one payer system). To ensure the confidentiality of all subjects, an encrypted health insurance number was used as the only identifier of each person in the study, to construct a final working database that included the complete health care utilization data for the 3 study populations. The Human Ethics Committee of the University of Manitoba and the Health Information Privacy Committee of Manitoba Health approved this project.

Study Populations

Obese women with OSAS: We selected 223 consecutive women diagnosed as having OSAS based on overnight polysomnography (see below) at the Sleep Disorders Centre, St. Boniface General Hospital from 1990 to 2003. They were resi-
dents of Manitoba who had complete health care utilization data stored in the Manitoba Health database during the period under study, 10 years before the initial diagnosis of OSAS. The diagnosis of OSAS was based on the clinical features and overnight sleep study data, using conventional criteria23 and the cases were independently reviewed by one of the authors (MK). The Epworth Sleepiness Scale (ESS) was used to document subjective daytime sleepiness.24

Obese controls: 223 women who met the WHO classification25,26 of obesity with body mass index (BMI) > 30 were selected from the general population using the 1996 National Population Health Survey.27,28 They were randomly matched to one obese woman with OSAS each, based on age and BMI.

Normal weight controls: In addition to obese women mentioned above, non-obese women were selected in a similar fashion. They were matched for age from the general population using the 1996 National Population Health Survey.

Both groups selected from the general population were residents of Manitoba continuously during the 10-year period under study. Health care utilization information for the 2 groups was investigated by linking the 1996 National Population Health Survey with the Manitoba Health database.

People whose entire health care service was not covered by the province of Manitoba for the 10 years of observation were excluded; also excluded were those who were not permanent residents in Manitoba, and Indians and military personal, whose health care is covered by the Canadian Federal Government (n = 12). Data for people on dialysis were excluded because the very high costs of this treatment could skew the results (n = 1). In addition, morbidly obese women with OSAS with BMI > 60 were excluded because it was difficult to match them with obese women from the general population with respect to BMI (n = 8).

Polysomnography

Comprehensive polysomnography included the monitoring of neurophysiological variables (EEG, chin EMG, EOG, anterior tibialis EMG) and cardiorespiratory variables (chest wall motion, abdominal motion, nasal pressure, ETCO₂, SpO₂, and EKG). The sleep data was analyzed using 30-sec epochs.29 Apnea-hypopnea index (AHI) was used as the measure of sleep apnea severity.23

Data Analysis

Physician fees and the number of physician visits were used as the measure of health care utilization. Costs are presented in Canadian dollars. Continuous variables were expressed as mean ± standard error (SE). The study period analyzed in this report was 10 years, spanning the period from 9 years prior to the diagnosis and the year of OSAS diagnosis. Annual health care utilization in OSAS patients was compared to health care costs of each control group in the same year. To assess the trend of physician fees and the number of physician visits before OSAS diagnosis, we calculated the slope of these 2 variables (per person per year) for the 2 years before OSAS diagnosis. Because use of health care may peak proximate to the time an OSAS diagnosis is made, costs or clinic visits related to the diagnosis were excluded in the year of the diagnosis to avoid this bias.

Table 1—Demographics and Characteristics of Study Populations at Baseline

<table>
<thead>
<tr>
<th></th>
<th>Obese women with OSAS (n=223)</th>
<th>Obese women (n=223)</th>
<th>Normal weight women (n=223)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>50.3 ± 0.7</td>
<td>49.1 ± 0.7</td>
<td>49.9 ± 0.6</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>39.3 ± 0.6</td>
<td>36.3 ± 0.4*</td>
<td>23.9 ± 0.4*</td>
</tr>
<tr>
<td>ESS</td>
<td>12.4 ± 0.4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>AHI (/hr)</td>
<td>28.1 ± 1.9</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

OSAS: obstructive sleep apnea syndrome, BMI: body mass index, ESS: Epworth sleepiness scale, AHI: apnea-hypopnea index, Significant pairwise differences (adjusted for multiple comparisons by Tukey-Kramer method): *P < 0.0001 vs obese women with OSAS. Values are expressed in mean ± standard error.

All statistical analyses were performed using SAS software (SAS Institute, Cary, NC, USA). Physician visits were modeled using a Poisson regression model; physician fees were log transformed and then modeled using a normal regression model to compare the 3 study groups over the observed period. The correction for repeated measures over time was controlled for in each model using generalized estimating equations (GEE). The GEE estimates combine cross-sectional and longitudinal associations that takes into account the within-group correlation and produce robust standard errors for testing hypotheses and computing confidence intervals.30 A univariate ANOVA was used to compare characteristics such as age and BMI between the 3 groups. Significance of individual differences was evaluated by the Tukey-Kramer test. Significance levels were set at P < 0.05 or P < 0.01.

RESULTS

There were 223 obese controls and 223 normal weight controls from the general population and 223 obese women with OSAS in the study. The characteristics of the 3 groups at baseline are presented in Table 1.

Physician Visits

The trends in physician visits 10 years before diagnosis are presented in Figure 1. Obese controls visited clinics more frequently than normal weight controls during the observed period (P < 0.0001). Physician visits by women with OSAS were more frequent than by obese controls in 10 years before diagnosis (P < 0.0001). Physician visits gradually increased in the 10 years before diagnosis in the women with OSAS. Physician visits in the year before diagnosis in the OSAS cases were more frequent than in the obese controls: 13.2 ± 0.73 visits vs 7.26 ± 0.49 visits (P < 0.0001). The trend prior to diagnosis was an increase of 1.16 visits per person per year in with the OSAS cases; among obese controls there was a decrease of 0.09 visits, and among normal weight controls there was a decrease of 0.16 visits.

Physician Fees

Physician fees for the 3 groups are presented in Figure 2. Physician fees were higher for obese controls compared to normal weight controls over the observed period (P < 0.0001); physician
fees were in turn higher for women with OSAS than for the obese controls 10 years before diagnosis (P < 0.0001). Physician fees in the OSAS group progressively increased in the 10 years leading up to diagnosis. Physician fees one year before diagnosis in the OSAS were significantly higher than in obese controls: $547.49 ± 34.79 vs $246.85 ± 20.88 (P < 0.0001).

Physician fees related to specific organ systems one year before diagnosis in normal weight women, obese women, and obese women with OSAS are presented in Table 2. More health care use was spent in the OSAS cases on physician fees for diseases of the circulatory system than obese controls one year prior to diagnosis. Physician fees for endocrine and metabolic diseases in OSAS cases ($38.30 ± 5.47) were more than twice those in obese women ($15.73 ± 2.87) in the year before diagnosis. In addition, higher health care use was present in the obese women with OSAS for diseases of genitourinary system (P < 0.05) and cancer (P < 0.01), compared to the obese women.

Additional analysis of the relative risk of pregnancy or birth for obese women with OSAS showed that OSAS cases are less likely to have a baby than obese women; the cases also were less likely to become pregnant than obese controls.

The trend of physician fees before diagnosis was an increase of $57.72 per person per year in the OSAS cases, an increase of $6.97 in the obese controls, and a decrease of $3.24 in the normal weight women.

**DISCUSSION**

To our knowledge, this is the first report on long-term healthcare utilization in obese women with OSAS, compared to those without OSAS and normal weight women. Expenditure on health care was higher in obese women than normal weight controls. Obesity is a risk factor for the development of hypertension, diabetes, cardiovascular diseases, and stroke, and therefore higher health care expenditure in obese women.

| Table 2—Mean Physician Fees Related to Specific Categories for the Obese Women with OSAS, Obese Women, and Normal Weight Women During the 10-Year Period |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Obese women                    | Obese women                      | Normal weight women              | Obese women                      |
| with OSAS                      | vs. obese women                  | with OSAS vs. obese women        | vs. normal weight women          |
| Major diagnostic categories    | P value                           | P value                          | P value                          |
| Endocrine and metabolic        | 0.001                            | 0.0001                           | 0.0001                           |
| disorders                      |                                  |                                  |                                  |
| Mental disorders               | 0.102                            | 0.149                            | 0.001                            |
| Diseases of the nervous system | 0.001                            | 0.0001                           | 0.0001                           |
| Diseases of the circulatory    | 0.01                             | 0.01                             | 0.001                            |
| system                          |                                  |                                  |                                  |
| Diseases of the respiratory    | 0.001                            | 0.001                            | 0.001                            |
| system                          |                                  |                                  |                                  |
| Diseases of the digestive      | 0.001                            | 0.001                            | 0.001                            |
| system                          |                                  |                                  |                                  |
| Diseases of the genitourinary   | 0.05                             | 0.001                            | 0.001                            |
| system                          |                                  |                                  |                                  |
| Cancer                          | 0.05                             | 0.001                            | 0.001                            |
| Infectious diseases            | 0.001                            | 0.001                            | 0.001                            |
| Other categories               |                                  |                                  |                                  |
| Medical tests                   | 0.001                            | 0.001                            | 0.001                            |
| Psychotherapy                   | 0.05                             | 0.001                            | 0.001                            |

OSAS: obstructive sleep apnea syndrome. Values are expressed in mean ± standard error. Costs are presented in the Canadian dollars.
than normal weight women would be expected. We found that obese women with OSAS had health care utilization 2.2 times as high as obese women before their diagnosis, and there was a progressive increase in health care expenditure in obese women with OSAS in the 9 years before diagnosis. This suggests that OSAS may cause additional burden on the health care system, potentially due to the development of more comorbidities in these obese women. Ronald et al reported that physician fees in patients with OSAS were approximately twice as high as those of age-matched controls in Manitoba. Tarasiuk and colleagues looked at health care utilization in patients with OSAS, using one billing system data in Israel, and concluded that health care expenditure in middle-aged and older patients with OSAS was 1.8 times as high as that of healthy controls. These results are similar to our findings, although subjects in both reports included men and women. In contrast, a report on health care utilization data in Manitoba, analyzed using only women with OSAS showed women with OSAS spent 2.6 times as much in physician fees in the year before diagnosis as controls matched for gender and age. However severity of obesity was not taken into account in control subjects in the previous study, which may lead to the magnitude of difference between subjects and controls on health care utilization. Health care expenditure on specific disorders before a diagnosis will be discussed later.

The mean BMI in the obese controls was 3 units less than that of obese women with OSAS. However, based on the recent WHO classification of obesity, the 2 groups fall into the same category: Obese class 2 (BMI: 35.0 to 39.9 kg/m²), as such should have an equally severe risk of developing comorbidities. Thus the actual difference of BMI between the 2 groups is considered to be acceptable in this study from the viewpoint of risk of comorbidities, which may also reflect health care utilization for the obesity-related comorbidities. Therefore, it is unlikely that the difference in number of physician visits and health care expenditures could be attributed to this small difference in BMI. It is likely that some of the obese controls may actually have OSAS, since obesity is a risk factor for this condition. This would tend to strengthen our findings.

Based on the subsequent analysis of physician fees related to specific disease categories, we found that obese women with OSAS were heavier users of health care resources for metabolic diseases than obese controls. Obesity is a risk factor for the development of diabetes mellitus and insulin resistance. Although the evidence about causal relationship between OSAS and diabetes mellitus or insulin resistance is a topic of current research, our data suggest that there is negative effect of OSAS on metabolic function. The exact mechanisms for metabolic abnormalities have not been clarified. Hypoxia caused by repetitive apnea and fragmented sleep negatively affects insulin resistance and glucose metabolism. Some intermediary mechanisms may be involved, including sustained sympathetic activation, increased oxidative stress, and activation of inflammatory pathways. These may alter metabolic function in patients with OSAS, which may lead to the development of diabetes or insulin resistance.

Health care expenditure on circulatory diseases in OSAS cases was significantly higher than in obese controls. Patients with OSAS are more frequently diagnosed with cardiovascular diseases and are heavy users of cardiovascular medications before their OSAS is diagnosed. Recent reports suggest that the inflammatory state caused by sleep apnea may play an important role in the development of atherosclerosis, which is associated with cardiovascular diseases. There is strong evidence that OSAS is an independent risk factor for hypertension. Other heart diseases such as heart failure, angina pectoris, myocardial infarction, and arrhythmia were also common in the women with OSAS, which may explain the higher physician fees for circulatory diseases in obese women with OSAS than obese women in this study.

Higher health care costs related to mental conditions were also found in OSAS cases than obese controls; cost for psychotherapy was also higher in women with OSAS than those without OSAS. Women with OSAS are more likely to receive a diagnosis of depression before OSAS diagnosis; female gender is predictive of depression (odds ratio 2.24; 95% confidence interval: 1.45 to 3.44) in patients with OSAS. Several previous studies support a positive association between depression or anxiety and OSAS; however, the results are still controversial because of methodological issues in the studies. However, our results show that mental conditions are more common in OSAS cases than in obese controls, as documented by increased health care resources used for mental conditions or psychotherapy.

Obese women with OSAS used more health care resources for cancer than those without OSAS. By contrast, health care expenditure for cancer in normal weight people was higher than in obese people, although the statistical difference of physician fees between the 2 groups was not significant. No previous reports have shown that sleep apnea may be associated with cancer in patients with OSAS. However, hypoxia, a common finding in OSAS, has been associated with enhanced tumor aggressiveness and progression. Chronic physiological stress and nocturnal hypoxia caused by abnormal breathing may thus play a role in the increased incidence of cancer in patients with OSAS. Further research needs to be done to demonstrate the relationship between sleep apnea and the occurrence of cancer. Another possibility that affects health care cost for cancer may be due to patients who continue to be treated with chemotherapy. Cost of chemotherapy depends on type of regimen, how long, and how often the treatment is performed. Thus, data of patients on chemotherapy also may have an influence on health care expenditure.

Healthcare costs for diseases of the genitourinary system in obese women with OSAS were approximately double that of the 2 control groups. Another analysis showed that women with OSAS are less likely to become pregnant than obese women controls. Sleep apnea frequently occurs in pregnant women; and this disorder is more common in obese pregnant women than normal weight pregnant women. It is possible that severe hypoxia, as well as obesity, may have adverse health effects in pregnant obese women with OSAS, possibly increasing the risk of pregnancy induced hypertension and/or having a negative effect on the developing fetus. However many of the cases and control subjects were older than 40 years of age. Thus further research evaluating younger women is required to demonstrate the influence of obesity and sleep apnea on the development of genitourinary diseases.

Study limitations include lack of data analysis adjusted for other potential confounders that may affect healthcare utiliza-
tion, such as socioeconomic status, race, education, smoking habit, and consumption of alcohol. Thus, the results should be interpreted with caution. In addition, some obese women controls may have undiagnosed OSAS. It has been reported that that more than 90% of women with moderate to severe OSAS may be undiagnosed. Furthermore, we did not calculate the costs related to reduced productivity due to cognitive impairment and excessive daytime sleepiness, a major symptom of OSAS, which may increase the risk of traffic accidents. Deaths and injuries associated with motor vehicle accidents may affect indirect financial burden attributable to OSAS.

In conclusion, obese women are heavier users of health care resources than normal weight women, and those with OSAS are in turn heavier users of health care resources than obese women. In contrast to the trend in the controls, physician fees and physician visits progressively increased in the 10 years leading up to diagnosis in obese women with OSAS. OSAS imposes a greater financial burden in obese women. Treatment of OSAS may reduce other comorbidities and contribute to the cost reduction of health care systems.

ACKNOWLEDGMENTS

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DISCLOSURE STATEMENT

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REFERENCES

31. Punjabi NM, Ahmed MM, Polotsky VY, Beamer BA, O’Donnell
41. Pien GW, Schwab RJ. Sleep disorders during pregnancy. Sleep 2004;27:1405-17