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Obesity and Presenteeism: The Impact of Body Mass Index on Workplace Productivity

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Learning Objectives

- Relate presenteeism, as reflected by scores in four dimensions of work and percentage productivity lost on the Work Limitations Questionnaire, to body mass index (BMI) in this study of 341 manufacturing employees.
- Identify any associations between BMI grouping and absenteeism.
- Estimate annual per-worker costs of health-related productivity losses and absenteeism as related to BMI.

Abstract

Objective: *To examine whether obesity is associated with increased presenteeism (health-related limitations at work).* ***Methods:*** *Randomly selected manufacturing employees (n = 341) were assessed via height and weight measures, demographic survey, wage data, and the Work Limitations Questionnaire. The Work Limitations Questionnaire measures productivity on four dimensions. Analyses of variance and analyses of covariance were computed to identify productivity differences based on body mass index (BMI).* ***Results:*** *Moderately or extremely obese workers (BMI ≥35) experienced the greatest health-related work limitations, specifically regarding time needed to complete tasks and ability to perform physical job demands. These workers experienced a 4.2% health-related loss in productivity, 1.18% more than all other employees, which equates to an additional $506 annually in lost productivity per worker.* ***Conclusions:*** *The relationship between BMI and presenteeism is characterized by a threshold effect, where extremely or moderately obese workers are significantly less productive than mildly obese workers.* (J Occup Environ Med. *2008;50:39–45*)

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In the early 1970s an editorial in the Lancet[1] identified obesity as the most important nutritional disease affecting affluent countries. Yet, over 30 years later, the US prevalence of obesity has increased dramatically among children, adolescents, and adults. Human obesity has serious consequences on health, including increased risks for depression,[2] noninsulin-dependent diabetes mellitus,[3,4] cancer,[5,6] rheumatoid and osteoarthritis,[7,8] hypertension,[9,10] and heart disease.[11,12] In addition, obesity has been found to reduce the quality of life for both men and women[2,4,13,14] and markedly reduces life expectancy,[15,16] The risks associated with overweight and obesity are alarming because approximately 66% of US adults are overweight or obese (body mass index [BMI] ≥25), with 32% being obese (BMI ≥30).[17]

The obesity-related costs to society are astounding. Finkelstein et al[18] recently estimated obesity-attributable medical expenditures in the United States to be $75 billion in 2003, with one half of these expenditures financed by Medicaid and Medicare. Employers are struggling with increasing costs related to health care and absenteeism. US employers are spending in excess of $900 billion per year for medical expenditures.[19] Researchers have estimated that costs attributed to obesity represent between 2% and 7.8% of the total health care expenditures of US businesses,[20,21] and that obesity is positively related to health care costs and absenteeism.[19,22–26] Schmier et al[27] reviewed eight studies and found that overweight or obese employees had higher sick

leave and disability use, and workplace injuries were higher for employees with higher BMIs. The authors concluded that obesity is an important driver of costs in the workplace.

Although previous studies have examined the relationship between absenteeism and obesity, there is a lack of published research about the effect of obesity and related diseases on presenteeism, or the degree to which workers are on the job but are not fully functioning because of medical or psychological conditions. The purpose of this study is to help fill that gap by identifying whether employees with obesity experience greater work limitations than those with lower BMIs.

Materials and Methods

Subjects

This study was conducted at eight manufacturing companies in Kentucky with workforces ranging from 150 to 350 employees. The investigators assigned unique numbers to employees of the eight participating companies. Using a software program (www.randomizer.com), employees were randomly selected to receive letters of invitation that described the study, selection criteria, and benefits of participation. Non–English-speaking persons and temporary or agency workers were excluded. Of the 622 employees invited to participate, 341 subjects (55%) consented and completed the baseline surveys and anthropometric measures. Participants represented both office-based and plant-based workers, with job titles including labor, safety, operations, human resources, engineering, and management.

Data Collection and Measurements

Participants completed an investigator-developed demographic and employment survey and the Workplace Limitations Questionnaire (WLQ).[28] The demographic and employment survey asked participants to provide information about their race, gender, age, job title, and absences. The WLQ is a self-administered survey measuring the degree to which health problems interfered with the respondent's ability to perform job activities during the previous 2 weeks.[28] The WLQ was designed by researchers at Tufts University and has been shown to be valid and reliable in previous studies.[28–30] Responses to the questionnaire's 25 items are combined into four dimensions of work: time demands, physical demands, mental or interpersonal demands, and output demands. The time scale addresses difficulties with meeting job expectations and scheduling demands. The physical scale focuses on workers' ability to perform their normal job tasks as influenced by bodily strength, movement, endurance, coordination, and flexibility. The mental-interpersonal scale examines cognitive tasks, sensory input, and interactions with others. The output scale focuses on the quantity, quality, and timeliness of meeting job demands. Scale scores range from 0 (ie, limited none of the time) to 100 (ie, limited all of the time). In addition, the WLQ allows for the calculation of a composite index score that reflects the overall percent productivity loss because of health limitations, relative to a healthy worker.[31]

Height and body weight were measured according to standard protocol by trained nurses, dietitians, and health educators. BMI was calculated using the formula of weight in kilograms divided by height in meters squared (kg/m^2). Employee wages were obtained by company human resource personnel for seven of the companies. One company chose not to divulge wage information.

Statistical Analysis

Participants were grouped into four categories based on their BMIs in keeping with guidelines from the National Institutes of Health: underweight and normal weight (BMI <25.0), overweight (BMI 25.0–29.9), mildly obese (BMI 30.0–34.9), and moderately or extremely obese (BMI ≥ 35.0). Demographic characteristics of gender, race, age, worker status (plant vs office), and income were compared across each group using analyses of variance (ANOVA) for continuous variables and chi-squared tests for categorical variables.

Worker presenteeism for the four WLQ subscales and percent productivity loss and absenteeism were then analyzed across the four BMI groups using univariate ANOVAs. Percent productivity loss was calculated using methods outlined by Lerner et al[31] in their technical report for the WLQ. Hours absent for the last 6 months were divided into those pertaining to the worker's own health and all other causes such as a family member's health or child care. The 6-month absenteeism data were annualized by doubling the reported number of absences. Arithmetic and geometric means were then calculated. Geometric means were used to describe the central tendency of rightly skewed data.[32]

The ANOVAs were followed by Student-Newman-Keuls (SNK) tests to compare each of the four obesity groups in a pairwise fashion. Analyses of covariance (ANCOVAs) were performed to test for differences in these outcomes across BMI groups, controlling for the following covariates: gender, race and ethnicity, age, plant versus office workers, and income quartile. The strategy of backward elimination was used to remove insignificant covariates from the statistical models, which resulted in estimating final models that included only the obesity group variable and significant covariates.

Annual costs of productivity loss were calculated by multiplying the percent of productivity loss times the sample's mean hourly wage, then multiplying by a standard 40-hour workweek over 50 weeks a year (2000 hours). Annual absenteeism costs for personal health-related reasons were calculated by multiplying

TABLE 1
Participant Characteristics According to BMI ($N = 341$)

Variable	Total	BMI Group: Underweight/Normal ($n = 76$) BMI < 25	Overweight ($n = 143$) BMI 25–29.9	Mildly Obese ($n = 79$) BMI 30–34.9	Moderately/Extremely Obese ($n = 43$) BMI ≥ 35
Gender*					
Male	197	29 (14.7%)	100 (50.7%)	46 (23.4%)	22 (11.2%)
Female	144	47 (32.6%)	43 (29.9%)	33 (22.9%)	21 (14.6%)
Race*					
White, non-Hispanic	311	67 (21.5%)	136 (43.7%)	73 (23.5%)	35 (11.3%)
Black, non-Hispanic	19	4 (21.1%)	4 (21.1%)	3 (15.8%)	8 (42.1%)
Age**	341	41.89 ± 10.81	43.35 ± 9.66	46.35 ± 9.58	41.93 ± 9.81
Worker status					
Plant	193	44 (22.8%)	78 (40.4%)	42 (21.8%)	29 (15.0%)
Office	146	32 (21.9%)	63 (43.2%)	37 (25.3%)	14 (9.6%)
Income ($n = 319$)					
<$32,635	79	14 (17.7%)	33 (41.8%)	20 (25.3%)	12 (15.2%)
$32,635–41,084	80	21 (26.3%)	25 (31.3%)	19 (23.8%)	15 (18.8%)
$41,085–59,062	81	15 (18.5%)	36 (44.4%)	21 (25.9%)	9 (11.1%)
>$59,062	79	23 (29.1%)	39 (49.4%)	13 (16.5%)	4 (5.1%)

*$P < 0.01$; **$P < 0.05$.
BMI, body mass index is calculated as weight (kg)/height $(m)^2$.

the sample's mean hourly wage times the arithmetic mean. Annual costs of productivity loss and absenteeism for the moderately or extremely obese were then compared with all other workers. Wage data were available for 309 participants.

Results

Description of Employees

Table 1 presents descriptive statistics for the sample. Approximately 91.5% of the 341 participants were white, 5.5% were black, and 1% or less each were Alaskan-American Indian, Hispanic, Asian, or other. The mean age of the participants was 43.6 ± 10.0 years (range 19–72). The mean BMI was 29.0 ± 5.5 (range 17.2–52.9). Overall, the majority of the participants were overweight or obese; only 22.3% workers had a BMI <25, whereas 41.9% workers were overweight, 23.2% were mildly obese, and 12.6% were moderately or extremely obese. In the lowest BMI group, only three workers were underweight (BMI ≤18.5), and the results were essentially unchanged when these three participants were excluded from the analysis.

There were significant differences across BMI groups in terms of gender, age, and ethnicity. Gender was related to BMI group in a nonlinear fashion, with women representing the highest proportion in the normal or underweight group (47 of 76 or 62%) and the lowest proportion among overweight workers (43 of 143 or 30%). Over half of the male workers were overweight and an additional third were obese. Two thirds of female workers were overweight or obese. Overweight workers were disproportionately white whereas obese workers were disproportionately black and had lower annual incomes. Age was also related to BMI group in a nonlinear fashion with the highest and lowest BMI groups being younger than the middle two BMI groups.

Presenteeism and Absenteeism

Table 2 describes the results for presenteeism and absenteeism, stratified by BMI. There were significant differences across the four BMI groups for the WLQ time subscale scores ($F(3,330) = 3.13$, $P < 0.03$). The SNK tests showed that participants whose BMI was 35.0 or greater experienced significantly more difficulty in completing work demands on time than participants in all other BMI groups. Marginal significance was found among the groups for the mean physical subscale scores ($F(3,334) = 2.53$, $P = 0.057$). The SNK comparisons showed that participants whose BMI was 35.0 or greater experienced significantly more difficulty with job-related physical tasks than did participants who were either overweight or mildly obese. Participants with a BMI <25 did not differ significantly from any other group in the physical subscale scores. There were no significant differences between group means on either the mental-interpersonal subscale scores ($F(3,335) = 1.48$, $P = 0.22$) or the output subscale scores ($F(3,332) = 1.17$, $P = 0.32$).

For the WLQ index of percentage productivity lost, the overall test comparing the four BMI groups was only marginally significant with a $P < 0.10$ ($F(3,326) = 2.21$, $P = 0.09$). Nevertheless, the percentage productivity lost for the moderately or extremely obese group (4.16%) was significantly higher than the mildly obese group (2.45%) at $P < 0.05$. Productivity loss for overweight and underweight or normal

TABLE 2
Mean Values of Work-Related Variables in Manufacturing Employees According to BMI ($N = 341$)

Outcome Variable	Total ($N = 341$)	Underweight/ Normal* ($n = 76$)	Overweight* ($n = 143$)	Mildly Obese* ($n = 79$)	Moderately/ Extremely Obese* ($n = 43$)	*F* and *P*
WLQ scales						
Time scale	12.26	12.04[a]	12.14[a]	9.32[a]	18.54[b]	$F(3,330) = 3.13$, $P < 0.03$
Physical scale	13.45	14.81[ab]	11.49[a]	11.27[a]	21.67[b]	$F(3,334) = 2.53$, $P = 0.06$
Mental/interpersonal	10.95	11.67[a]	11.31[a]	8.38[a]	13.22[a]	$F(3,335) = 1.48$, $P = 0.22$
Output scale	10.45	10.59[a]	11.14[a]	7.79[a]	12.86[a]	$F(3,332) = 1.17$, $P = 0.32$
Productivity loss (%)	3.12	3.25[ab]	3.13[ab]	2.45[a]	4.16[b]	$F(3,326) = 2.21$, $P = 0.09$
Absenteeism (hr)						
Arithmetic mean	55.84	63.76	26.86	91.08	73.48	
Geometric mean	10.50	16.14[a]	6.10[b]	14.34[a]	14.82[a]	$F(3,337) = 5.12$, $P < 0.002$
High absenteeism						
>2 wk/yr, n (%)	41 (12.0)	12 (15.8)	11 (7.7)	13 (16.5)	5 (11.6)	
>4 wk/yr, n (%)	21 (6.2)	6 (7.9)	4 (2.8)	7 (8.9)	4 (9.3)	

*Means that do not share a common superscripted letter (a,b) are significantly different according to the Student-Newman-Keuls test at $P < 0.05$.

BMI, body mass index is calculated as weight (kg)/height $(m)^2$; WLQ, Work Limitations Questionnaire.

weight BMI workers did not differ significantly from any other group.

The total sample had an arithmetic mean of 55.84 missed hours of work because of personal health absenteeism, with a range of 0 to 160 days of missed work leading to right-skewed absenteeism data. The mildly obese and moderately or extremely obese groups had the greatest average number of annual hours absent for personal health reasons, 91.08 and 73.48 hours, respectively. The overweight group averaged 26.86 hours absent.

Because of right skewing of personal health-related absenteeism data, geometric means were calculated for the groups and an ANOVA revealed that the groups were significantly different ($F(3,337) = 5.12$, $P < 0.002$). The overweight group was absent significantly fewer hours than all other groups (SNK comparisons). Interestingly, the underweight or normal weight group had the highest number of hours absent on the geometric scale at 16.14, more than double that of the overweight group.

Twelve percent of the total sample missed more than 2 weeks (80 hours) of work time because of personal health reasons and 6.2% missed more than 4 weeks (160 hours) of work during the previous year. The overweight group had the lowest percentage (7.7%) of workers who missed more than 2 weeks of work and lowest percentage of those who missed more than 4 weeks of work (2.8%). The mildly obese and the moderately or extremely obese groups had the highest percentages of workers who missed more than 2 weeks of work (16.5% and 11.6%, respectively), as well as those who missed over 4 weeks of work (8.9% and 9.3%, respectively).

Repeating the comparisons in Table 2 using ANCOVAs, none of the covariates (gender, race and ethnicity, age, plant vs office worker, income quartile) were significant in any of the models except the physical subscale, in which the plant versus office worker comparison was significant ($F(1,331) = 11.93$, $P < 0.0006$). The mean was 18.36 for plant and 9.82 for office workers. This indicates that, with the exception of the physical subscale, the results in Table 2 were unaffected by multivariate adjustment. After controlling for plant versus office worker, there was no significant difference among the BMI groups for the physical subscale.

Costs

Annual costs per worker because of health-related productivity losses and absenteeism were calculated based on the sample-wide mean hourly wage of $21.44. The mean per-person cost for presenteeism was $1337.86 compared with $1197.21 for absenteeism.

The moderately or extremely obese group had the greatest loss of productivity for each of the subscales with a mean of 4.16% compared with the mean for all other workers at 2.98%. Overall, the moderately or extremely obese workers experienced a health-related loss in productivity 1.18% higher than the mean percentage for all other workers. Annual costs per moderately or extremely obese worker for loss of productivity and absenteeism were calculated using the sample-wide mean hourly wage of $21.44. The annual presenteeism cost of $1783.81 for the moderately or extremely obese worker was $506 above the annual presenteeism cost of $1277.82 for all other workers in the study. The annual absenteeism cost of $1575.41 for the moderately or extremely obese worker was $433 above the absenteeism cost of $1142.76 for all other workers.

Discussion

Extreme obesity was associated with significantly greater health-

related limitations in the workplace. The job limitations most affected by obesity were those with time and physical demands, whereas mental or interpersonal and overall output-related demands were not affected by obesity. The WLQs time and physical demand subscale items identified, respectively, the subject's difficulty to move as necessary to perform essential job functions and the subject's difficulty to complete work in the expected amount of time. There are several plausible explanations for these results. Moderately or extremely obese people often have difficulty moving because of their body size and the large amount of weight they carry.[4,33] In addition, pain has been found to be prevalent in obese persons[33] and is often associated with musculoskeletal or joint-related pain in the feet, knees, ankles, and back.[34] Obesity has been found to be related to the development of osteoarthritis and rheumatoid arthritis[7,8,34] and carpal tunnel syndrome.[35,36] All of these physical conditions are likely to have an impact on the worker's ability to move without pain and could result in a decrease in productivity in those job functions that are physically demanding.[37,38] Another possible reason for the difference in the physical scale across BMI groups may be the decreased balance and coordination seen in obese versus normal weight persons.[39] Obesity has also been found to be a risk factor for sleep apnea[40] and heart disease.[11,12] Workers with these conditions may experience weakness and shortness of breath, making the worker tired or slow and thus more likely to have greater difficulty in meeting time demands for completing job tasks.

It is not surprising that plant workers had a significantly higher mean for the physical demand scale than office workers had. Working in the plant areas of the eight manufacturing companies requires workers to be able to adapt to the work environment and to engage in various physical movements, including bending, stretching, squatting, pushing, and walking. In contrast, office workers often sit for long periods and have the capability of adjusting their work environment to meet their physical abilities.

The effect of obesity on productivity was nonlinear and appears to exhibit a threshold effect, in which limitations were concentrated among moderately or extremely obese individuals (BMI $\geq$35), whereas overweight (BMI 25–29.9) and mildly obese individuals (BMI 30–34.9) did not experience any adverse productivity effects. This threshold effect suggests that workplace interventions for reducing obesity may have a significant economic benefit to employers, even if they only produce modest weight changes that enable workers to move from the category of moderate or extreme obesity to mild obesity.

The study's results support other research that has indicated that a weight loss of 10% can yield substantial health and economic benefits. These results have important implications to those individuals and companies who are overwhelmed with the belief that dramatic weight loss is needed to achieve positive health and productivity outcomes for the majority of their workers.

The dollar value cost of presenteeism among moderately or extremely obese workers was $506 per worker each year compared with $433 per worker for health-related absenteeism above that of the other workers. Thus, health-related limitation on the job may be even more economically significant than health-related time off the job. Furthermore, absences do not necessarily cost the employer the full value of the worker's time to the extent that these are unpaid absences and that other workers are able to cover the missing shifts. Meanwhile, presenteeism is always a cost to employers because the worker is receiving a full paycheck despite reductions in productivity.

Given the prevalence of workers with BMI $\geq$35 in our sample (12.6%), the impaired productivity of moderate or extreme obesity translates into an overall annual presenteeism cost of $6376 for a company with 100 workers, compared with a firm without any moderately or extremely obese workers. This suggests that workplace interventions targeting extreme obesity could easily produce overall cost savings to employers—without even factoring in possible reductions in health care costs paid by the employer-provided health insurance plans. Decreasing absenteeism because of improved health would lead to further costs savings.

It is important to note that 12% of the workers missed 2 or more weeks of work and that 6.2% missed over 4 weeks of work because of personal health reasons. Many of the workers had additional absences due to nonhealth reasons including child care or a family member's health. This high rate of absenteeism may lead to production delays in manufacturing plants as well as place workers at risk for loss of employment.[41] It is interesting to note that the overweight group missed the least number of days because of personal health reasons. Because this overweight group represented the greatest proportion of workers (41.9%), this represents a positive finding for companies who are becoming increasingly concerned about the growing epidemic of overweight and obesity and the effects on illness, health care costs, and absenteeism.

The worksite offers unique opportunities to reach a large number of individuals at a relatively low cost by providing information, activities, and social support to promote healthier lifestyles. Environmental and policy interventions can support improved diet and physical activity habits among workers. Healthy lifestyles are likely to result in lowered costs related to medical care, absenteeism, and productivity, which will have an impact on corporate profits.

Limitations

There were limitations in this study that should be addressed. First, there may be differences in productivity caused by other factors, rather than truly being caused by obesity. Nevertheless, we used ANCOVA to adjust for many possibly confounding variables, and found that the results were largely unchanged. One unobserved feature that is perhaps most concerning would be other underlying diseases that are affecting both BMI and worker productivity; however, such differences (such as cancer leading to weight loss and decreased productivity) would likely lead us to underestimate the true productivity loss because of obesity.

Another limitation is that participation in our study may not have been random. Though subjects were selected randomly, only 55% of those selected ultimately participated, which may have introduced a selection bias. In particular, it is possible that workers who were sensitive about their weight or overwhelmed with work-related difficulties chose not to participate—in which case, our results again may underestimate the true adverse effects of obesity on productivity.

Lastly, the sample used in this study is certainly not representative of all companies in the United States. The results are most applicable to other manufacturing companies. Furthermore, our results may be specific to the geographic region of the country in which our companies were clustered. Future research exploring different workplace populations is needed to determine the generalizability of our results to other settings.

Conclusions

Obesity can have a negative impact on workers not only through absenteeism but also presenteeism, that is, a reduced productivity on the job. In particular, health effects on productivity are concentrated among the most obese workers with BMIs of 35.0 and greater, suggesting that employers should consider workplace interventions targeting obesity. Even modest weight loss could result in hundreds of dollars of improved productivity costs per worker each year.

Future research should be conducted to determine if workers who are missing the greatest number of days because of personal health reasons are more productive than workers who come to work sick and demonstrate presenteeism. Furthermore, research should be conducted to determine the effectiveness of workplace interventions targeting a reduction in obesity.

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