Arch Public Health
2008, 66, 88-101

Overweight and obesity in primary practice. A patient-based study

by

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Abstract

Objective: To identify factors related to overweight and obesity in a multi-ethnic primary care practice population.

Methods: Cross-sectional based on questionnaire survey and medical examination. Multinomial logistic regression analysis was used to identify predictors of overweight and obesity. Four hundred and seventy adult patients (≥16 years old) who visited the Jordbro Health Centre (JHC), Haninge Municipality, Stockholm, Sweden, participated in this study. Measurements: Body mass index (BMI). Overweight, defined as (BMI>25 kg/m2), and obesity (BMI>30 kg/m2) were explored in relation to sociodemographic characteristics, symptoms, chronic disease, lifestyle factors and medical tests.

Results: In this study 68.5% were overweight or obese, i.e. had a BMI > 25 kg/m2. Among those, 39.3% were overweight and 29.2% obese. The OR for subjects born outside Sweden and overweight was 1.36 (95%CI 1.07-1.22) and for hypertension and obesity 2.60 (95%CI 1.23-5.49). Subjects with musculoskeletal disorder had a fourfold OR for obesity (OR=4.72, 95%CI 1.89-10.20). The OR for having high fasting plasma glucose and obesity was 3.83 (95%CI 1.90-7.71) while for subjects with high fasting serum triglycerides the OR for overweight was 4.75 (95%CI 2.08-10.88) and for obesity 11.80 (95%CI 4.83-28.84).

Conclusions: Patients with musculoskeletal disorders need further attention with regard to the risk of developing obesity even if the relationship between obesity and muskuloskeletal disorders can be explained bidirectionally and it may be worthwhile to consider both as deserving attention separately and as risk factors for each other. Furthermore, this study suggests a liberal attitude toward screening for diabetes among the overweight and obese patients.

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Keywords: Body Mass Index (BMI), cardiovascular disease, general practice, primary care, musculoskeletal disorders.

Introduction

Obesity is one of the major risk factors for cardiovascular disease (CHD), stroke and diabetes (1-7). In the meantime, the prevalence of obesity is increasing worldwide and the epidemic of obesity is a threat to the western countries (1;3;5;8-10).

The high prevalence of overweight and obesity is a major public health problem. For example, Must et al. report from the US that 63% of men and 55% of women had a body mass index (BMI) of 25 kg/m2 or greater (1). Among Canadians, 39% and 13% of older adults were classified as overweight and obese (11). The prevalence of overweight and obesity is high among other populations as well (3;5;8;9;12).

A broad range of diseases and health complaints are associated with obesity (13-15). In fact, many conditions and risk factors are clustered among the overweight and obese, and this emphasises the need for a concerted effort to prevent and treat obesity rather than just its associated comorbidities (1;2). The high prevalence of multiple, clustered behavioural risk factors is a challenge for primary care and public health systems (16). Overweight and obesity are the most common conditions in general practice and are generally managed in association with diabetes, hypertension and metabolic syndrome. However, obesity is a complex, multifactorial condition and requires generalised interventions to prevent it among the adult population (3).

Quality of life is also affected by overweight and obesity. Hence, obesity is associated with physical function measures (17). Furthermore, a higher BMI in middle age is associated with poorer quality of life in older age (18). In addition to the increased comorbidity among the obese, obesity is also related to shorter life expectancy and mortality (4).

The main aim of this study was to identify sociodemographic characteristics, life style factors, symptoms and somatic conditions associated with overweight and obesity in a multi-ethnic primary care practice population. Another aim was to access the magnitude of this association separately for both overweight and obesity in a multinominal regression analysis. The present investigation is part of a comprehensive programme entitled “Improving Health Care in Jordbro (IHCJ)” to assess the influence of socio-demographic characteristics, including country of birth, as well as morbidity on health care and drug use among patients resident in Jordbro, a small multi-ethnic subcommunity in Stockholm, Sweden.

The study was approved by the Research Ethics Committee at the School of Medicine, Karolinska Institute, Stockholm, Sweden, and conforms to the Declaration of Helsinki.

Methods

Subjects and setting

A full description of the methodology is provided elsewhere (19-20). The patient sample was recruited between October 2002 and April 2003 from adult patients (≥16 years old) consecutively presenting for routine visits at the Jordbro Health Centre (JHC). In total 470 adult patients participated in this study. We informed all patients who visited the JHC centre about the study and distributed forms asking them to indicate whether they were interested in the study or not and to give some personal information. The patients were requested to complete the questionnaire at the surgery if possible; otherwise they could return it when they had an appointment scheduled for the examination (second part of the study). The registered patients were invited for an examination one by one, following the order of the register. They were asked to come to the surgery having fasted for 12 hours, i.e. they were not allowed to eat, smoke or take medication during the 12 hours before the visit and the examination but were allowed to drink water. The patients were to hand over the questionnaire if it had not been returned previously, and the answers were checked before the medical examination was performed and the blood samples were taken for analysis.

A nurse well trained in measuring weight, height and blood pressure performed these measurements and assisted in other practical parts of the survey. The study population consisted of patients who were registered during the first four weeks. If the patients visited the health care centre several times during the study period they were included only once.

Measurements

The study consisted of two parts: (a) a general questionnaire (19-22) and (b) a medical examination. The general questionnaire with questions on socio-demographic characteristics (Table 1), lifestyle, health status and symptoms was handed out to the patients. The socio-demographic variables included, in addition to age and gender, family situation (e.g. whether the patient lived alone, with another adult and/or with children) and country of birth.

The symptom questionnaire consisted of 13 somatic yes/no questions about the presence of symptoms during the previous month (Table 2). The somatic symptoms were: abdominal pain, backache, pain in arms, headache, chest pain, fainting, palpitations, breathlessness, constipation, nausea, fatigue and sleep disturbances. One further question requested the patients to evaluate their overall health on a 5-point scale, ranging from 1 (‘bad’) to 5 (‘perfect’). Patients were asked to state whether they had any chronic diseases or conditions from a list of 16 common somatic diseases (Table 3).

Outcome variables

Body mass index (BMI) was calculated as weight in kilograms/(height in metres)^2 and categorised on the basis of the World Health Organisation (WHO) classification (23). Overweight was defined as BMI≥25 kg/m^2 and obesity as BMI≥30 kg/m^2.

Explanatory variables

The socio-demographic variables were clustered – e.g. age was grouped into: 16-44, 45-64 and 65+ years of age. In the final analysis the groups 16-24, 25-44, 45-65 and 65+ was used. Gender: male and female. For living conditions the variables were: living alone, living with another adult and living with children <7 years: yes and no. Working: yes and no. Disability pension: yes and no. Country of birth: Sweden, other Nordic countries, other European countries and the rest of the world.

Perceived health was defined on a seven-point scale, ranging from score 1, 'very bad', to score 7, 'excellent, could not be better'. Symptoms: The patient questionnaire (PQ) consisted of 13 yes/no questions about the presence of somatic symptoms during the previous month.

Lifestyle factors: Smoking, snuff-taking and former smokers: yes and no. Alcohol drinking: never, seldom, yes, occasionally or often.

Medical Examination: blood pressure (BP): systolic (SBP) and diastolic (DBP); heart rate (pulse) during one minute; fasting plasma glucose, fasting serum cholesterol and triglycerides. The thresholds of the variables fasting plasma glucose (6.1 Mmol/l), serum cholesterol (5 Mmol/l) and triglycerides (2 Mmol/l) are based on Swedish recommendations and Diagnostic Criteria for Diabetes Mellitus (24). Spirometry: mean values were calculated for forced expiratory volume for 1 second (FEV1) in per cent, forced expiratory capacity in per cent (FVC) in per cent, and peak expiratory flow (PEF) in per cent. Electrocardiography: The results were judged and grouped in two categories – normal and abnormal – if there was any deviation from the normal ECG.

Common somatic disease consisted of 16 common conditions. The presence of a condition was regarded as 'yes', 1 and the absent as 'no', 0.

Statistical methods

The data were analysed with the JMP and Stata software packages (25;26). Standard methods were used to obtain summary statistics, such as means, prevalence and other measures. Student and Chi-square tests or Fisher's exact test were used to calculate the p-values. All significant tests were two-tailed. The crude means were calculated by one-way ANOVA and the p-values for comparisons among groups were calculated by the two sample t-test.

Significant variables found in the bivariate analyses were included in the final multinominal analysis after examining the possible correlations and collinearities between those variables. Initially a simplified logistic model was tested with the BMI level <25 and ≥25 as dichotomised variables. This model identified hypertension, musculoskeletal disorders, smoking and fasting triglycerides as related to BMI. The model performed well (according to the goodness-of-fit test) [Hosmer-Lemeshow chi^2 (8) =6.89, prob>chi^2=0.5481]. However, we aimed to test these associations for overweight and obesity separately in order to identify the risk factors related to each condition.

The Odds Ratios (OR) and 95% Confidence Intervals (95%CI) were calculated by means of multinomial logistic regression analysis. In the analysis the BMI level <25 was regarded as a reference group and the other BMI levels (BMI≥25-29.9 and ≥30) were compared. The age variable was used in its continuous form.

Results

Population distribution

The mean age of respondents was 54 years and ranged from 18 to 87 years, and the median was 55 years. The mean BMI for the whole population was 27.8, 95% CI (27.3-28.2), and the median BMI was 27.3. The mean BMI was almost similar across the age groups 16-44, 45-64 and 65 years and above (Table 1). Of respondents aged 16-44 years, 35% had a BMI<25 while for the other age groups, 31% and 29.4% respectively were of normal weight, defined as BMI<25. Overweight, defined as BMI=25-29.9, was most common among respondents aged 45-64 years while obesity, defined as BMI ≥30, was most common among the younger respondents aged 16-44 years.

There were no significant differences between males and females regarding the mean BMI. A substantially higher proportion of males were overweight (BMI=25-29.9) compared to females but the pattern was opposite for obesity (≥30). However, it may be noted that there is a much higher proportion of females with BMI < 25 than males. Living alone was related to higher BMI mean and also the proportion of overweight and obesity was more prevalent among respondents living alone than respondents not living alone. Respondents with disability pension had significantly higher BMIs; a significantly higher proportion of these respondents was obese compared to respondents who did not receive a disability pension. However, overweight was more common among respondents who were not on disability pension.

It is interesting that respondents born outside Sweden, irrespective of their country of birth, had a higher BMI. Overweight was most common among respondents born in other European countries followed by respondents born outside Europe, while obesity was more common among respondents born in other Nordic countries followed by respondents born outside Europe.

TABLE 1. Population characteristics in relation to body mass index (BMI)

		Body mass index (BMI)					
	N*	Mean	P-value	<25	25−29.9	>30	P-value
N	470	27.3		147 (31.5)	183 (39.3)	136 (29.2)	
Age (years)							
Mean (95% CI)	470	54.0 (52.6−55.4)		53.1	54.8	54.0 (51.4−56.6)	0.6075
		BMI		**%**	**%**	**%**	
16-44	120	27.7	0.9208	35.0	34.2	30.8	0.6643
45-64	203	27.7		31.0	39.4	29.6	
65-	143	27.9		29.4	43.4	27.3	
Gender							**0.0088**
Male	170	28.1	0.2498	25.3	48.2	26.5	
Female	296	27.6		35.1	34.1	30.7	
Living alone							0.0742
Yes	126	28.6	**0.0270**	24.0	40.8	35.2	
No	335	27.5		34.2	38.7	27.0	
Working							0.3200
Yes	202	28.1	0.1603	34.2	39.6	26.2	
No	249	27.4		29.7	37.8	32.5	
Disability pension							**0.0038**
Yes	77	29.2	**0.0052**	20.8	35.1	44.2	
No	340	27.4		34.4	39.7	25.9	
Country of birth**			**0.0057**				**0.0013**
Sweden	278	27.1[A]		36.7	39.2	24.1	
Nordic countries	56	28.6[B]		32.1	23.2	44.6	
Europe	58	28.6[B]		20.7	48.3	31.0	
Other	69	29.1[B]		18.8	44.9	36.2	

* Total N not equal to 470 due to missing values for some individual questions
** Level not connected by the same letter are significantly different.

BMI and somatic symptoms

Respondents reporting symptoms such as arm pain, chest pain and dizziness had significantly higher BMIs than non-symptomatic respondents (Table 2). Among respondents with arm complaints 32.9% were obese as compared to 23.7% among the non-symptomatic. Among respondents with chest pain 40.6% were obese as compared to 26.2% among those without chest pain.

BMI and chronic disease/conditions

Respondents with hypertension, angina, diabetes, joint diseases, chronic pain, musculoskeletal disorders and eye disease had significantly higher BMIs (Table 3). Also, the proportion of obese was significantly higher for respondents with hypertension, angina, diabetes, joint diseases, musculoskeletal disorders and eye diseases than healthy respondents. For example, 55.6% of diabetes respondents were obese, 49.4% of respondents with musculoskeletal disorders were obese and the figures for hypertension and angina were 38.9 and 46.0% respectively.

BMI in relation to plasma glucose, lipids, smoking and electrocardiogram

The higher the BMI the lower the forced expiratory capacity in per cent (FVC; Table 4). Diastolic blood pressure was higher among the obese respondents than the non-obese respondents.

The level of fasting plasma glucose was significantly higher among overweight and obese respondents than among normal-weight respondents, but the level of fasting serum triglycerides increased with increasing BMI levels. The obese respondents had the highest triglyceride levels.

Also, a high proportion of respondents with high levels of fasting plasma glucose and triglycerides was obese. For example, 55.31% of respondents with high fasting triglycerides were obese and 37.7% were overweight. An interesting finding is that smokers had lower BMI than non-smokers. The mean BMI was not significantly different between those with normal or abnormal ECGs.

Logistic regression analysis

The logistic regression model shows that being born outside Sweden, having hypertension, musculoskeletal disorder and having high fasting triglycerides (>2 Mmol/l) were related to higher BMI while being current smoker was related to lower BMI.

Multinomial logistic regression analysis

Table 5 shows the multinomial analysis of BMI levels and the related covariates. In this analysis the BMI level <25 was regarded a comparison group. Respondents born outside Sweden had significantly higher OR for being overweight (BMI 25-29.9) or obese (BMI≥30) than respondents born in Sweden and respondents with normal weight (BMI<25). The OR for respondents born outside Sweden was 1.36 (95%CI 1.07-1.72) for overweight as compared to respondents born in Sweden with normal weight.

The hypertensive respondents had an OR of 2.60 (95%CI 1.23-5.49) for obesity as compared to non-hypertensive respondents with normal weight. Respondents with musculoskeletal disorders had an OR of 4.72 (95%CI 1.89-10.20) for being obese as compared to not having any musculoskeletal disorder and having normal weight.

TABLE 2. Body mass index (BMI) in relation to somatic symptoms

	BMI, mean										
	Symptomatic		BMI level among symptomatic, %				BMI level among not-symptomatic, %				P-value
Symptoms	Yes	No	N	<25	25−29.9	≥30	N	<25	25−29.9	≥30	
Abdominal pain	28.1	27.7	126	31.8	38.9	29.4	334	31.4	39.2	29.3	0.9973
Backache	28.1	27.5	216	32.4	35.2	32.4	224	30.7	42.6	26.6	0.2209
Pain in arms	**28.4**	**26.8*****	283	**27.9**	**39.2**	**32.9**	177	**37.3**	**39.0**	**23.7**	**0.0466**
Headache	28.1	27.8	175	33.7	35.4	30.7	285	30.2	41.4	28.4	0.4406
Chest pain	**29.1**	**27.4*****	96	**27.1**	**32.3**	**40.6**	363	**32.8**	**41.1**	**26.2**	**0.0213**
Dizziness	**28.6**	**27.7***	122	**29.1**	35.8	35.1	323	32.2	40.9	26.9	0.2185
Fainting	29.1	27.7	22	27.3	36.4	36.4	438	31.7	39.3	29.0	0.7539
Palpitations	27.8	27.8	88	34.1	35.2	30.7	372	30.9	40.1	29.0	0.6985
Breathlessness	28.7	27.6	84	31.0	32.1	36.9	376	31.7	40.7	27.7	0.1928
Constipation	28.1	27.7	114	35.1	32.5	32.5	346	30.6	41.3	28.3	0.2422
Nausea	28.3	27.6	141	29.8	38.3	31.9	319	32.3	39.5	28.2	0.7094
Fatigue	28.2	27.3	262	31.3	35.1	33.6	198	31.8	44.4	23.7	**0.0440**
Sleep disturbances	27.8	27.8	201	34.8	34.3	30.9	259	29.0	42.9	28.2	0.1642

* p<0.05
** p<0.01
*** p<0.005.

TABLE 3. The body mass index (BMI) distribution among diseased and non-diseased respondents

	BMI, mean										
	Diseased		BMI level among diseased				BMI level among non-diseased				P-value
Diseases/conditions	Yes	No	N	<25	25−29.9	≥30	N	<25	25−29.9	≥30	
Hypertension	29.1	27.3***	113	23.0	38.1	38.9	348	34.2	39.7	26.2	**0.0165**
Angina	29.9	27.6**	37	16.2	37.8	46.0	421	32.8	39.4	27.8	**0.0333**
Heart failure	29.8	27.7	14	21.4	42.9	35.7	447	31.8	39.2	29.1	0.7002
Diabetes	31.4	27.4***	45	11.1	33.3	55.6	415	33.7	40.0	26.3	**<0.0001**
Asthma	27.7	27.8	56	33.9	35.7	30.4	405	31.1	39.8	29.1	0.8379
Chronic obstructive lung disease	27.6	27.8	13	46.2	30.8	23.1	448	31.0	39.5	29.5	0.5115
Joint disease	28.4	27.0**	253	28.1	37.9	34.0	208	35.6	40.9	23.6	**0.0380**
Chronic pain syndrome	28.8	27.5**	108	28.7	33.3	38.0	353	32.3	41.1	26.6	0.0732
Neoplasm	27.0	27.8	18	27.8	55.6	16.7	442	31.5	38.7	29.9	0.3086
Psychiatric disorder	27.1	27.8	38	42.1	31.6	26.3	423	30.5	40.0	29.6	0.3261
Neurological disorder	28.0	27.8	26	30.8	46.2	23.1	434	31.6	38.9	29.5	0.7132
Musculoskeletal disease	29.7	27.3***	89	22.5	28.1	49.4	372	33.6	41.9	24.5	**<0.0001**
Eye disease	29.2	27.5**	64	21.9	35.9	42.2	397	33.0	39.8	27.2	**0.0368**
Ear disease	28.2	27.8	38	26.3	42.1	31.6	422	32.0	38.9	29.2	0.7710
Gastrointestinal disorder	28.1	27.7	113	36.3	31.9	31.9	348	29.9	41.7	28.5	0.1704
Genito-urinary disorder	28.4	27.7	57	28.1	38.6	33.3	403	31.8	39.5	28.8	0.7487

* $p<0.05$
** $p<0.01$
*** $p<0.005$.

TABLE 4. Body mass index (BMI) in relation to lung capacity, heart rate and electrocardiogram

		BMI			P-value
		<25	25−29.9	≥30	
	Mean	N=147	N=183	N=136	
FEV[1], %	93.4	94.1	94.0	92.0	0.5356
FVC[2], %	91.6	93.5	91.4	89.7	0.141
PEF[3], %	90.5	88.7	91.7	91.0	0.4240
Heart rate/minute	69.6	68.7	70.6	69.3	0.3769
SBP	134.6	132.3	135.3	136.4	0.2228
DBP[4]	80.2	78.6[A]	80.6[AB]	81.3[B]	**0.0480**
Fasting glucose, mean[4]	5.9	5.5[A]	5.7[B]	6.5[B]	**<0.0001**
Fasting glucose, %					**<0.0001**
≥ 6.1 Mmol/litre	30.1	23 (18.9)	38 (31.2)	61 (50.0)	
< 6.1 Mmol/litre	26.9	122 (36.0)	142 (41.9)	75 (22.1)	
Fasting triglycerides, mean[4]	1.52	1.15[A]	1.58[B]	1.83[C]	**<0.0001**
Fasting triglycerides, %					**<0.0001**
>2 Mmol/litre	30.9	6 (7.1)	32 (37.7)	47 (55.3)	
≤ 2 Mmol/litre	27.4	137 (37.2)	144 (39.1)	87 (23.6)	
Fasting cholesterol, mean	5.33	5.28	5.40	5.31	0.6654
Fasting cholesterol, %					0.3241
≥ 5 Mmol/litre	27.9	91 (30.7)	122 (41.2)	83 (28.0)	
< 5 Mmol/litre	27.7	51 (32.9)	53 (34.2)	51 (32.9)	
Current smoker, %					**0.0181**
Yes	26.7*	53 (41.1)	46 (35.7)	30 (23.3)	
No	28.2	92 (27.8)	134 (40.5)	105 (31.7)	
Former smoker, %					0.8410
Yes	27.9	42 (30.4)	57 (41.3)	39 (28.3)	
No	27.6	100 (32.3)	119 (38.4)	91 (29.4)	
Taking snuff, %					0.8739
Yes	27.4	10 (35.7)	10 (35.7)	8 (28.6)	
No	27.8	135 (31.3)	171 (39.6)	126 (29.2)	
ECG[5], %					0.2276
Normal	27.5	69 (29.2)	90 (38.1)	77 (32.6)	
Abnormal	28.0	77 (33.9)	92 (40.5)	58 (25.6)	

[1] Forced Expiratory Volume for 1 second (FEV1) in %
[2] Forced Vital Capacity (FVC) in %
[3] Peak Expiratory Flow (PEF) in %
[4] Levels not connected by the same letter are significantly different.
[5] Electrocardiogram
* p<0.001.

TABLE 5. Multinomial analysis showing Odds Ratios (OR) and 95% Confidence Intervals (95% CI) of Body Mass Index (BMI) levels and the related covariates

		BMI 25−29.9 vs. <25		BMI $\geq$ 30 vs. < 25	
Covariates		OR	95% CI	OR	95% CI
Age, years	16-24	Reference	−	Reference	−
	25-44	1.00	0.31−3.25	3.42	0.59−19.79
	45-64	1.41	0.46 4.27	1.25	0.22−7.10
	> 64	1.46	0.44−4.81	1.15	0.19−7.06
Female		0.79	0.47−1.32	1.29	0.67−2.46
Living alone		1.46	0.83−2.56	1.54	0.77−3.08
Born outside Sweden		**1.36**	**1.07−1.72**	1.19	0.89−1.58
Disability pension		1.29	0.65−2.58	1.43	0.61−3.34
Hypertension		1.89	1.00−3.55	**2.60**	**1.23−5.49**
Angina		1.72	0.62−4.74	2.44	0.76 −7.85
Musculoskeletal disorder		1.73	0.85−3.50	**4.72**	**1.89−10.20**
Fasting glucose > 6.1[1] High (low reference)		1.02	0.55−1.91	**3.83**	**1.90−7.71**
Fasting triglycerides > 2[1]		**4.75**	**2.08−10.88**	**11.80**	**4.83−28.84**
Current smoking		0.63	0.36−1.09	**0.28**	**0.14 −0.58**

[1]Mmol/l
BMI <25 is the comparison group.

It is interesting to see that respondents with fasting plasma glucose >6.1 Mmol/l had higher ORs for obesity (BMI≥30) than respondents with lower levels. Having high fasting serum triglycerides was related to overweight (BMI 25-29.9) and obesity (BMI≥30). Smokers had very low OR for both overweight and obesity. They had 82% decreased odds for obesity.

Discussion

In this study 68.5% were overweight or obese, i.e. had a BMI≥25 kg/m^2. Among those, 39.3% were overweight and 29.2% obese. Furthermore, country of birth, hypertension, musculoskeletal disorders, fasting plasma glucose, fasting serum triglycerides and smoking status were significantly and independently related to overweight and obesity.

The results of this study are partially in line with other studies which report that being male, low educated and married was related to overweight (11;27). We found in this study that a higher proportion of males were overweight, but the proportion of obese was larger among females. In contrast to other studies, we found that respondents living alone were at higher risk of being overweight or obese, and living with an adult was also related to a lower BMI and lower risk of obesity (11). We found in this study that smokers were of low BMI compared to non-smokers. However, this is in line with other studies (28). Other authors have likewise reported ethnical variations in obesity (1;11). In Sweden it has been reported that the non-natives have higher cardiovascular disease and mortality (29-32). The higher prevalence of overweight and obesity among these groups could partially explain this increased risk.

Of particular interest is that respondents with musculoskeletal disorders had more than four times higher odds of being obese compared to respondents without musculoskeletal disorders. For example, Kortt et al. report a significant relationship between musculoskeletal disorders and obesity (14). One possible explanation for this increased risk is the sedentary lifestyle and immobilisation, which could be related to complaints from musculoskeletal organs. However, this calls for particular attention, and the general practitioner should be aware of the risk of immobilisation associated with musculoskeletal disorders and subsequent risk of overweight and obesity. Furthermore, respondents with hypertension had higher OR than non-hypertensive respondents for being obese. This, however, is in line with other studies (3;7).

Another important finding in this study is that respondents with high levels of fasting plasma glucose (>6.1 Mmol/l) had increased OR for obesity when the impact of confounders was taken into account. One explanation is that among the obese respondents there are respondents with non-diagnosed diabetes. This calls for a liberal attitude to controlling plasma glucose among the overweight and obese patients because of the risk of developing diabetes. Also a group of diabetes patients with metabolic syndrome could be among those with high fasting glucose. However, this means that some of those patients are not well controlled.

The strength of this study is that BMI was based on factual weight and height measured at the surgery, and by this procedure we reduced the bias in reporting weight and height. Furthermore, a wide range of variables were explored. In addition to that, the response rate was relatively high and the study population is multiethnic primary care patients. However, this study has some limitations. Since the study is cross-sectional, causal relationships cannot be identified. Another limitation is that we only used BMI and not other measures such as waist-to-hip circumference ratio. However, BMI is easy to use in general practice.

In conclusion, country of birth and high level of fasting triglycerides were related to overweight but hypertension, musculoskeletal disorders, fasting plasma glucose, fasting serum triglycerides and smoking were significantly and independently related to obesity. The high prevalence of overweight and obesity in this population emphasises the need for concerted efforts to prevent and treat overweight and obesity and its associated comorbidities. Furthermore, patients with musculoskeletal disorders need further attention with regard to risk of developing obesity. The relationship between obesity and musculoskeletal disorders found in this study can be explained bidirectionally. In this type of study the direction or the cause cannot be explained. However, it may be worthwhile to consider both as deserving attention separately and as risk factors for each other.

This information can be used by public health practitioners to identify patients at risk and to design health strategies that target these patients. Furthermore, the results of this study suggest a liberal attitude towards screening for diabetes among obese patients.

Acknowledgements

This study was supported by grants from the Stockholm County Council (Dagmar & ALF Fund) and the Haninge Municipal Council (Economic Target to Large Cities).

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