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Hasler, G ; Pine, D S ; Gamma, A ; Milos, G ; Ajdacic, V ; Eich, D ; Rössler, W ; Angst, J

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The associations between psychopathology and being overweight: a 20-year prospective study

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ABSTRACT

Background. Psychiatric disorders and being overweight are major health problems with increasing prevalence. The purpose of this study was to test the hypothesis that being overweight is associated with a range of psychiatric conditions including minor and atypical depressive disorders, binge eating, and aggression.

Method. Prospective community-based cohort study of young adults ($n = 591$) followed between ages 19 and 40. Information derived from six subsequent semi-structured diagnostic interviews conducted by professionals over twenty years. Outcomes were being overweight [body-mass index (BMI) > 25] and average yearly weight change between ages 20 and 40 (BMI slope).

Results. 18·9% of the participants were classified as being overweight. Being overweight turned out to be a stable trait: 77·7% of subjects were assigned to the same weight class at each interview. Atypical depression and binge eating were positively associated with both, increased weight gain and being overweight, while psychiatric conditions associated with aggressive behaviors (aggressive personality traits, sociopathy) were positively associated with being overweight, but were not related to the rate of weight change. Generalized anxiety disorder was negatively associated with overweight. These results persisted after controlling for substance use, levels of physical activity, demographic variables and family history of weight problems.

Conclusions. This study shows relatively strong associations between eating-related and aggressive psychopathology and being overweight. Given the high prevalence rates of these conditions, this study encourages further research on the causality of psychopathology-overweight associations that might provide insight on novel preventive approaches for major health problems.

INTRODUCTION

Being overweight is a major health problem with nearly half a billion of the world's population considered to be overweight or obese (Mokdad *et al.* 1999; Rössner, 2002). Being overweight is associated with increased risk for coronary heart disease, high blood pressure, high blood cholesterol level, type 2 diabetes mellitus, gallbladder disease, osteoarthritis and overall mortality (Must *et al.* 1999). In addition, being overweight is associated with important social and economic consequences (Gortmaker *et al.* 1993), and weight-related morbidity is estimated to account for up to 8% of health care budgets in all parts of the world (Rössner, 2002).

Recent findings from neurobiological investigations suggest associations between psychopathology and weight regulation. Dopamine, a neurotransmitter that modulates rewarding properties of food and is involved in the development of obesity (Wang *et al.* 2001), plays

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a role in the pathophysiology of sleep-wake disturbances and other neuropsychiatric conditions (Rye & Jankovic, 2002). Serotonin that has been implicated in the control of eating behavior, meal size and body weight (Leibowitz & Alexander, 1998; Kuikka *et al*. 2001; Ricca *et al*. 2002), is associated with psychiatric symptoms such as aggressive behaviors (Stanley *et al*. 2000), depression (Neumeister *et al*. 2002), and anxiety-related traits (Lesch *et al*. 1996).

In clinical studies, some psychiatric disorders appeared to be associated with increased body-mass index (BMI). Being overweight was reported in subjects with binge eating disorder (Dingemans *et al*. 2002), bipolar disorder (Fagiolini *et al*. 2002), narcolepsy (Schuld *et al*. 2000), idiopathic hypersomnia (Bassetti & Aldrich, 1997), and a family history of antisocial personality (Black *et al*. 1992). In contrast, low body mass indices have been reported in adolescence with obsessive-compulsive disorder (Henninghausen *et al*. 1999). However, these results of clinical studies turned out to be weak or inconsistent in epidemiological studies (Kittel *et al*. 1978; DiPietro *et al*. 1992; Istvan *et al*. 1992; Lamertz *et al*. 2002; Wyatt *et al*. 2003). Clinical studies may be vulnerable to biases related to the effects of treatment (Elmslie *et al*. 2001) or help-seeking behavior (Britz *et al*. 2000). On the other hand the assessment of psychopathology by questionnaire and the cross-sectional design of most epidemiological studies in this field may contribute to inconsistent results, because acute psychiatric symptoms may produce transient weight change, and thus disguise the long-term relations of psychiatric conditions and BMI. Therefore longitudinal epidemiological studies with valid psychiatric diagnostic information based on narrow psychopathological definitions are needed to clarify the relationship between psychopathology and being overweight.

In the current study we use data from a prospective community study with valid and reliable diagnostic information collected over a 20-year follow-up period. The sample was enriched for psychiatric and psychosomatic syndromes by over-representation of subjects with high symptom scores assessed by a psychological symptom questionnaire. Based on prior studies we hypothesize that overweight is associated with a range of psychiatric conditions: subthreshold depressive disorders (Istvan *et al*. 1992), the atypical depressive subtype (Kendler *et al*. 1996), binge eating (Dingemans *et al*. 2002), sleep disorders (Bassetti & Aldrich, 1997; Kripke *et al*. 2002), hypomanic symptoms (Fagiolini *et al*. 2002), and aggressive behaviors and aggressive personality traits (Black *et al*. 1992; Pine *et al*. 1996, 1997). Second, we test whether psychiatric disorders associated with pathological body weight are associated with increased weight gain in young adults. Finally, we examine associations between psychopathology and overweight after controlling variables considered in previous studies to be potential confounders. These include substance use, anxiety disorders, demographic variables, family history of weight problems, and level of physical activity (Moore *et al*. 1962; Friedman & Brownell, 1995; Pine *et al*. 1997, 2001; Faith *et al*. 2002).

METHOD

Sample

The Zurich Cohort Study is comprised of a cohort of 4547 subjects (2201 males, 2346 females) representative of the canton of Zurich in Switzerland, who were assessed in 1978 with the Symptom Checklist 90-R (Derogatis, 1977) and a questionnaire for socio-demographic data. The study is based on a stratified sample with an over-representation of risk cases. In order to increase the probability of psychiatric syndromes, a subsample of 591 subjects (292 males, 299 females) was selected for interview, with two-thirds consisting of high scorers (defined by the gender-specific 85th percentile or more of the SCL-90) and a random sample of those with scores below the 85th percentile. After a complete description of the study to the subjects, written informed consent was obtained from subjects. The screening took place in 1978 at age 19, the first and second interviews in 1979 and 1981, the third and fourth interviews in 1986 and 1988, the fifth interview in 1993 and the sixth in 1999.

Across 20 years, 62·1% of the original sample continued to participate in the study and the following proportions participated in specific numbers of interviews: 47% in all 6 interviews; 63% in 5 interviews; 74% in 4 interviews; 82% in 3 interviews; and 91·4% in at least 2 interviews. Those who had dropped out did not

differ significantly from the 1999 participants regarding the risk group at study entry and most demographic characteristics (Eich *et al*. 2003). Subjects with missing BMI at all interviews (1 case) and BMI below 17 (4 cases) were excluded from the analysis. We excluded subjects with BMI below 17 because the associations between psychopathology and pathological underweight were not a focus of this study. Twelve subjects had a lifetime diagnosis of bulimia nervosa; they were included in the diagnostic category 'binge eating'.

Diagnostic interview

The Structured Psychopathological Interview and Rating of the Social Consequences for Epidemiology (SPIKE) was administered in the participants' homes by psychiatric residents and clinical psychologists with extensive clinical training (Angst & Dobler-Mikola, 1985). This interview schedule assesses a number of somatic syndromes, including insomnia; headache; gastrointestinal, cardiovascular, respiratory, perimenstrual and sexual syndromes; and psychological syndromes, including depression, hypomania, anxiety, phobia, obsessive-compulsive disorder, eating disorder, post-traumatic stress disorder, substance abuse and suicidality.

Numerous demographic, social status and clinical measures including personality traits, social supports, life events, coping behaviors, health attitudes and behaviors, and quality of life were assessed in specific interviews. Socioeconomic status was defined according to subjects' occupational status and categorized into four classes (1 = college student; 2 = employee; 3 = worker, apprentice; 4 = pupil, unskilled worker).

Screening probes based solely on the major phenomenologic features of each syndrome (e.g. depressed, irritable, sad mood) were administered for each diagnostic category. Positive endorsement of the entry probe was followed first by queries about specific symptoms and second by their duration, frequency and severity, and treatment history and impairment. Personal and family history of the syndromes was assessed for all subjects, irrespective of endorsement of the diagnostic screening question for each section. The childhood/adolescence section of the interview assessed several aspects of behavior and emotional function retrospectively, including conduct disorder symptoms, antisocial, aggressive and delinquent behaviors.

The validity of the SPIKE has also been assessed by comparing physician ratings and medical records to an administration of the SPIKE by another clinician among 140 patients drawn from psychiatric clinics or social-psychiatric services in the canton of Zurich (Illes, 1981; Busslinger, 1984; Meier, 1985) and from a local hospital (Pfortmüller, 1983). The SPIKE rating of the diagnostic level of depression was found to have high sensitivity and specificity (0·95 and 0·59 respectively, for major depression and 0·83 and 0·63 respectively, for minor depression). Likewise, the SPIKE had high sensitivity for detecting subthreshold depression, anxiety and mania (i.e. respective kappas of 0·9, 0·83, 0·67), confirming its ability to capture subclinical medical and psychiatric complaints.

Assessment of BMI

BMI is frequently used to estimate body fat in clinical practice and epidemiological research, partially because of the ease with which it is measured (Willett *et al*. 1999). Among middle-aged adults, BMI is strongly correlated with fat mass measured densitometrically and adjusted for height (r is approximately 0·9 for both men and women) (Willett, 1998). Studies show that people tend to exaggerate their height and underestimate their weight, which would underestimate BMI. However, a Swiss national survey showed that BMI under-reporting depends on age being minimal in young adults between ages 20 and 40 (Schutz & Woringer, 2002). Moreover, validation studies suggest that this bias is unlikely to affect conclusions about associations between BMI and psychopathology, particularly in longitudinal studies (Stunkard & Albaum, 1981; Stewart, 1982; Stevens *et al*. 1990). For the Zurich cohort study height was determined by self-report in 1979, weight was determined by self-report at each interview. The mean BMI of this study was comparable to that of the population of young adults living in Switzerland as a whole (Eichholzer *et al*. 1999).

Diagnostic definitions

We used diagnostic information from all interviews. Classification of psychiatric disorders were made by algorithms on the basis of DSM-III criteria (GAD, panic disorder), DSM-III-R

criteria (major depressive disorder, phobias, obsessive-compulsive disorder), and DSM-IV criteria (substance abuse/dependence). The diagnostic criteria for atypical depression including the reverse vegetative symptoms overeating and oversleeping, leaden paralysis, and rejection sensitivity were described by Angst *et al.* (2002). Exclusion criteria were never applied in order to investigate in an unbiased way the associations between diagnostic categories.

At least four binges (i.e. eating, in a discrete period of time, an amount of food that is definitely larger than most people would eat with a sense of lack of control and subsequent distress; interviewers were specifically instructed about the definition of binge eating) over one year were required for binge eating. This definition turned out to be useful and valid for longitudinal epidemiological investigations (Vollrath *et al.* 1992), and can be seen as a subthreshold category of binge eating disorder that additionally requires eating binges occurring at least 2 days a week for 6 months (Dingemans *et al.* 2002).

Sociopathy was defined as having antisocial, aggressive, or delinquent behavior in childhood and adolescence. The level of physical activity was assessed by interview based on three questions concerning sports activity, walking, and watching television (response categories: more than once a week, at least once a week, at least once a month, less than once a month). The coefficients for the correlations between the three items assessing physical activity levels ranged from 0·02 to 0·11. A family history of weight problems was defined as having one or more overweight or obese first-degree relatives.

Assessment of personality

Personality traits were assessed by the Freiburg Personality Inventory (FPI; half form B; Fahrenberg *et al.* 1970), a self-report inventory, which is the most widely used personality index in German-speaking countries. The FPI was administered to subjects at the third and forth interview, and scores were highly stable across interviews. Nine primary factors can be derived from the instrument. Three alternative secondary factors (aggression, extraversion, and autonomic lability) were derived through factor analysis of a large population-based study in Switzerland (Angst & Clayton, 1986). These z-transformed factors (mean = 0, S.D. = 1) are used in the current study, because they provided a better fit to the data and were more representative of the current sample of young Swiss adults than the factors developed by the original authors of the instrument. The factor autonomic lability is similar to the personality dimension neuroticism.

Statistical analysis

We examined associations between psychopathology and both, being overweight defined by a cut-off on the BMI distribution and BMI as a continuous variable, since these two analytic approaches answer conceptually different questions. The categorical approach considers the association with an abnormal category associated with severe medical consequences; the continuous approach, in contrast, examines the associations between psychiatric symptoms and normal variations in relative weight, as distributed throughout the population. For the definition of being overweight we used a cut-off of BMI 25. In prior studies BMI above 25 at age 35 was associated with a 50% increase in mortality from cardiovascular disease among both, female and male individuals (Stevens *et al.* 1998; Willett *et al.* 1999).

An initial exploration showed an increase of BMI over time, and an association between baseline BMI and the duration of the follow-up period [$F(5, 575) = 3{\cdot}92$, $p < 0{\cdot}01$]. In order to control for the effect of age we examined the BMI > 25 at age 34 (5th interview); this turned out to be the 79th percentile. If a subject's BMI was above this cut-off in more than 50% of the interviews over time, he or she was classified as being overweight for the analysis of this study. To verify our results we conducted a secondary analysis using generalized estimating equations (Zeger & Liang, 1986) with being overweight defined as having a BMI > 25 at each interview.

We estimated the association of each independent variable with being overweight using logistic regression models controlling for stratified sampling (0 = SCL-90R low scorer at age 19; 1 = SCL-90R high scorer at age 19) and gender. In addition, we analyzed the data for male and female subjects separately controlling for stratified sampling. To find a final regression model predicting being overweight we included

all variables that reached statistical significance in the univariate analyses and reduced the number of variables by backward elimination to avoid multi-collinearity. To retain sufficient predictor variables, a probability level above 10% for variable removal was chosen.

To test associations between psychiatric and behavioral variables and the rate of weight gain (BMI slope) we analyzed the longitudinal data using a random effects model with subject as cluster and a first-order autoregressive within-cluster correlation structure including repeated measures of BMI as dependent variable, age, psychiatric and behavioral variables as fixed effects, and intercept as random effect. Variable-by-age interactions for affective disorders, eating disorder symptoms, smoking, levels of physical activity and education were included because associations between these variables and weight change may be stronger than those with the BMI level (DiPietro *et al.* 1992; Flegal *et al.* 1995; Barefoot *et al.* 1998; Fairburn *et al.* 2000). We referred to estimates for fixed effects as intercept coefficients and to estimates for variable-by-age interactions, i.e. average BMI change over time, as slope coefficients (see Table 5). The form of the random effects model is identical to that used in ordinary multiple regression, but the methods used to estimate the regression coefficients are modified to account for the correlation between repeated measures on the same subject. We reduced the number of fixed effects by backward elimination to avoid multi-collinearity (probability level for removal: 10%). Software from SAS (Cary, NC, USA) was used for all statistical analyses. We used the macro COLLIN from SAS-L by Mathew Zack to calculate collinearity diagnostics from variance-covariance matrix in linear and nonlinear regression models (Davis *et al.* 1986).

All *p* values indicated in this paper represent nominal *p* values; no corrections for multiple testing were made.

RESULTS

Table 1 shows the average BMI in males and females at each interview. Based on our algorithm, we classified 111 (18·9%) of the 586 subjects included in the study as being overweight (see methods). Among male subjects, 70 (24·1%) were overweight; among female subjects, 41 (13·9%) were overweight. Being overweight turned out to be a remarkably stable trait over 20 years. 78·6% of subjects were assigned to the same weight class at each interview, 88·4% of subjects were assigned to the same weight class at 75% or more of the interviews in which they participated. Higher thresholds for defining overweight (BMI > 27·5, BMI > 30·0) did not yield stronger psychopathology-overweight associations.

Table 1. *Sample and design of the Zurich Cohort Study*

		Men		Women		
Year	Age	*n*	BMI (S.D.)	*n*	BMI (S.D.)	Assessment
1978	19	2201		2346		Screen
1979	20	292	21·6 (2·4)	299	20·8 (2·6)	Interview
1980	21	234		270		Questionnaire
1981	22	220	22·2 (2·5)	236	21·0 (2·8)	Interview
1986	27	225	22·6 (2·6)	232	21·0 (3·0)	Interview
1988	29	200	22·9 (2·8)	224	21·3 (3·0)	Interview
1993	34	192	23·4 (2·9)	215	21·8 (3·7)	Interview
1999	40	162	24·2 (3·2)	205	22·6 (4·2)	Interview

BMI, Body-mass index.

Univariate associations

Table 2 shows the odds ratios for being overweight and psychiatric disorders for male and female subjects adjusted for stratified sampling, and for all subjects adjusted for gender and stratified sampling. Major depression, recurrent brief depression, and minor depression were not associated with being overweight. However, the atypical depressive subtype was associated with being overweight among males and females, and hypomanic symptoms were related to being overweight among males. Oversleeping as a subjective symptom was associated with being overweight in females, whereas insomnia was not related to being overweight.

Generalized anxiety disorder was negatively associated with being overweight among males and among all subjects, while other anxiety disorders were not. Neither use of antidepressants, nor alcohol abuse, drug abuse, or tobacco dependence were associated with being overweight. Binge eating increased the odds for being overweight more than threefold in both, male and female subjects. As shown in Table 3, aggression as a personality trait and conduct disorder symptoms were associated with being

Table 2. *Odds ratios for being overweight adjusted for gender and sampling: associations with psychiatric conditions*

Diagnosis/symptom	Prev†	Males ($n=292$) OR (95% CI)	Females ($n=299$) OR (95% CI)	Total sample ($n=591$) OR (95% CI)
Major depression	22·8	0·9 (0·5–1·8)	0·9 (0·4–1·7)	0·9 (0·6–1·5)
Recurrent brief depression	21·3	0·9 (0·5–1·7)	0·8 (0·4–1·6)	0·9 (0·5–1·4)
Minor depression	14·0	1·4 (0·7–3·0)	1·0 (0·4–2·6)	1·2 (0·6–2·1)
Atypical depressive subtype	17·0	2·0 (1·0–4·2)*	2·9 (1·3–6·5)**	2·8 (1·7–4·7)***
Hypomanic symptoms	45·6	1·9 (1·0–3·7)*	1·2 (0·6–2·6)	1·6 (1·0–2·6)
Antidepressant medication	5·8	2·1 (0·7–6·0)	0·7 (0·2–1·8)	1·1 (0·5–2·2)
Insomnia	32·9	1·0 (0·5–2·0)	0·9 (0·4–2·4)	1·0 (0·6–1·7)
Oversleeping	33·8	0·8 (0·4–1·6)	2·7 (1·1–6·2)*	1·3 (0·8–2·1)
Panic disorder	3·4	1·9 (0·6–5·8)	1·3 (0·4–3·5)	1·5 (0·7–3·2)
Generalized anxiety disorder	13·1	0·3 (0·1–0·9)*	0·6 (0·3–1·6)	0·4 (0·2–0·9)*
Phobic disorders	15·5	0·7 (0·3–1·6)	1·5 (0·7–3·0)	1·1 (0·6–1·8)
Obsessive-compulsive disorder	4·4	0·8 (0·2–4·0)	1·7 (0·5–5·6)	1·3 (0·5–3·3)
Binge eating	8·4	3·6 (1·3–10·0)*	3·8 (1·7–8·8)**	3·8 (2·0–7·1)***
Alcohol dependence/abuse	17·9	1·1 (0·6–2·0)	0·6 (0·2–2·0)	1·0 (0·6–1·7)
Drug dependence/abuse	8·1	1·0 (0·5–2·1)	1·4 (0·4–5·0)	1·1 (0·6–2·1)
Tobacco dependence	40·5	1·2 (0·7–2·2)	1·3 (0·6–2·7)	1·2 (0·8–1·9)

OR, Odds ratio; CI, confidence interval.
† Prevalence rates were weighted back to reflect the original sample ($n=4547$).
* $p<0·05$, ** $p<0·01$, *** $p<0·001$.

Table 3. *Odds ratios for being overweight adjusted for gender and sampling: associations with personality characteristics, levels of physical activity and demographic variables*

Characteristic	Prev[a]	Males ($n=292$) OR (95% CI)	Females ($n=299$) OR (95% CI)	Total sample ($n=591$) OR (95% CI)
FPI: aggression†		1·1 (0·7–1·5)	1·7 (1·1–2·5)*	1·3 (1·0–1·7)
FPI: extraversion†		1·5 (1·0–2·1)*	1·2 (0·8–1·8)	1·4 (1·0–1·8)*
FPI: autonomic lability†		0·9 (0·6–1·3)	1·3 (0·9–2·0)	1·1 (0·8–1·4)
Sociopathy	2·3	3·2 (1·3–7·5)**	—[b]	4·5 (2·1–9·8)***
Walking, hiking†		0·7 (0·5–0·9)*	0·9 (0·6–1·3)	0·8 (0·6–1·0)*
Sports activity†		0·9 (0·6–1·1)	0·7 (0·5–1·0)*	0·8 (0·6–1·0)*
Watching television†		1·2 (0·9–1·5)	2·1 (1·4–3·2)***	1·4 (1·1–1·8)**
Residence in an urban area	72·8	0·7 (0·4–1·3)	0·5 (0·2–1·00)*	0·6 (0·4–1·0)*
Low educational level	39·6	2·1 (1·2–3·7)**	3·4 (1·7–6·8)***	2·6 (1·7–3·9)***
Household income[c]‡		0·9 (0·4–1·7)	1·2 (0·8–1·9)	1·1 (0·7–1·5)
Low socioeconomic status	54·0	2·0 (1·1–3·7)*	3·8 (1·9–7·6)***	2·6 (1·6–4·2)***
Parents' household income[c]§		0·7 (0·5–0·9)*	0·7 (0·5–0·9)*	0·7 (0·6–0·9)**
Family history of weight problems	41·2	1·8 (1·0–3·2)*	2·0 (1·0–4·3)*	1·9 (1·2–3·0)**

OR, Odds ratio; CI, confidence interval.
† Mean = 0, S.D. = 1; ‡ mean = 1·8, S.D. = 0·7; § mean = 3·9, S.D. = 1·0.
[a] Prevalence rates were weighted back to reflect the original sample ($n=4547$).
[b] Four out of five cases were overweight (Fisher's exact test, $p<0·01$).
[c] One unit was defined as 1000 Swiss Francs per month.
* $p<0·05$, ** $p<0·01$, *** $p<0·001$.

overweight among females, whereas extraversion was associated with being overweight among males. Sociopathy was strongly related to being overweight among males and females.

Table 3 also shows the associations between being overweight and demographic variables: being overweight was positively associated with residence in a rural area, low educational level, low socioeconomic status and family history of weight problems; parents' household income was negatively associated with being overweight.

We did not find any gender-by-predictor or sampling-by-predictor variable interaction as predictors of overweight.

Table 4. *Adjusted odds ratios for being overweight: associations with psychopathology and demographic variables*

Variable	AOR	95% CI
Female gender	0·4**	0·2–0·7
SCL-90R high scorer sample	0·5*	0·3–0·9
Atypical depression	2·1*	1·1–3·9
Generalized anxiety disorder	0·3**	0·1–0·7
Binge eating	3·2**	1·5–6·7
Sociopathy	4·0**	1·6–10·4
Sports activity (⩾once a week)	0·6	0·4–1·1
Parental income (1000 SF)†	0·8	0·6–1·0
Low educational level	2·5**	1·4–4·4
Family history of weight problems	1·9*	1·1–3·2

AOR, Adjusted odds ratio; CI, confidence interval.
† SF, Swiss Francs per month.
* $p<0·05$; ** $p<0·01$.

Multivariate associations

As shown in Table 4, female gender and SCL-90R scores above the 85th percentile at age 19 were negatively associated with being overweight. Among the psychiatric variables, sociopathy, binge eating and atypical depression continued to be positively associated with overweight in the multivariate model, whereas generalized anxiety disorder was negatively associated with being overweight. In addition, a low educational level and a family history of weight problems persisted to be positively associated with being overweight. Sports activity and parental income were negatively associated with overweight at a trend level ($p<0·10$).

The results of the secondary analyses using generalized estimating equations with being overweight defined as having a BMI > 25 at each interview were consistent in magnitude and significance with the results presented here.

Random effects model for BMI

The random effects model met the convergence criteria and collinearity diagnostics were negative (Belsley *et al.* 1980). As shown in Table 5, binge eating, a family history of weight problems and a low educational level were positively associated with BMI slope (i.e. the average rate of weight gain between ages 20 and 40), and there was a trend for a positive association between atypical depression and BMI slope. Female gender, the level of sports activity, and tobacco dependence were negatively associated with BMI slope. Sociopathy was positively associated with the BMI level, and there was a trend that generalized anxiety disorder was negatively associated with the BMI level. Generalized anxiety disorder, aggressive personality traits and sociopathy were not associated with BMI slope.

DISCUSSION

Being overweight turned out to be a remarkably stable characteristic over 20 years. This result is consistent with the Framingham Study showing that the body weight of the average adult changed only 10% over 20 years (Belanger *et al.* 1988). A prevalence rate for being overweight below 20% in this sample is low compared to prevalence rates found in the USA (Flegal *et al.* 1998). Because in this study being overweight is a rather deviant than a normative characteristic, the overweight-psychopathology associations may be stronger than in other samples. In contrast to previous studies in young adults (Becker *et al.* 2001), the associations between obesity (BMI > 30) and psychopathology were not stronger than those between overweight (BMI > 25) and psychopathology.

Although minor depressive disorders were not associated with being overweight, we found strong evidence for atypical depression and binge eating being associated with overweight and with increased average weight gain between ages 20 and 40. Although this is not surprising, because the diagnostic criteria of both conditions include increased food intake, this is the first community study showing associations between these conditions and weight gain related to clinically significant weight problems (i.e. BMI > 25 at age 35) in young adults after controlling for confounding variables. Despite the strong relationship between major depression and binge eating (Vollrath *et al.* 1992), this study showed that major depression *per se* was not associated with weight problems, and that the association between binge eating and being overweight was independent from overeating as atypical depressive symptom. In addition, hypersomnia was associated with being overweight in females suggesting that the association between clinically relevant hypersomnia and increased BMI (Bassetti & Aldrich, 1997) may generalize to non-clinical female populations.

Table 5. *Random effects model for body-mass index (BMI) (n = 591)*

Variable	Intercept coefficients	Slope coefficients	Standard error	*p* value
Age (years)		0·097	0·028	<0·001
Female gender	−0·063		0·362	N.S.
Female gender × age interaction		−0·044	0·014	<0·01
Atypical depression	−0·647		0·407	N.S.
Atypical depression × age interaction		0·027	0·016	<0·10
Binge eating	−0·215		0·486	N.S.
Binge eating × age interaction		0·054	0·019	<0·01
Generalized anxiety disorder	−0·469		0·283	<0·10
FPI: aggression (personality trait)	0·032		0·017	<0·10
Sociopathy	1·525		0·536	<0·01
Tobacco dependence	0·575		0·356	N.S.
Tobacco dependence × age interaction		−0·035	0·014	<0·05
Level of sports activity	0·422		0·173	<0·05
Level of sports activity × age interaction		−0·019	0·007	<0·01
Low educational level	−0·085		0·380	N.S.
Low educational level × age interaction		0·044	0·015	<0·01
Low socioeconomic status	0·238		0·120	<0·05
Family history of weight problems (FH)	−0·206		0·352	N.S.
FH × age interaction		0·033	0·014	<0·05

Coefficients were also adjusted for stratified sampling as covariate.
N.S. = not significant ($p \geqslant 0{\cdot}1$).

Consistent with our hypothesis, hypomanic symptoms were found to be associated with being overweight in males. This result is in line with several clues to an association between the bipolar spectrum and being overweight: a high prevalence of being overweight in patients with bipolar I disorder was reported, that could not be explained by drug-induced changes in food preference alone (Fagiolini *et al.* 2002); the factor 'disinhibition' was found to be crucial in mediating affective disorders and weight gain (Weissenburger *et al.* 1986). However, the association between hypomanic symptoms and overweight was relatively weak; it was not found in females and did not remain significant in the multivariate model, and hypomanic symptoms were not associated with BMI slope.

Aggressive and antisocial behaviors were relatively strongly associated with overweight and, consistently, aggression and extraversion assessed as adult personality traits were also associated with overweight, although the latter associations were relatively weak. However, none of the variables concerning aggression was related to increased weight gain between 20 and 40 years. These results are consistent with the previous studies that found associations between conduct disorder symptoms respectively physical aggression and increased BMI (Pine *et al.* 1997; Tremblay *et al.* 1998).

To our knowledge, this is the first study that provides evidence for a relatively strong negative association between generalized anxiety disorder and being overweight after controlling for potentially confounding variables. The result is in line with a cross-sectional community study that showed an inverse relation between obesity and childhood anxiety (Moore *et al.* 1962). Because this finding is not based on a hypothesis, it has to be interpreted with caution and needs to be confirmed by future studies. Interestingly, generalized anxiety disorder has been found to be less prevalent in binge eaters than in controls (Vollrath *et al.* 1992; Yanovski *et al.* 1993), and aggressive impulsivity has been associated with low anxiety (Fowles, 2000). One may speculate that discounting of delayed reward that has been found in antisocial personality disorder (Petry, 2002) may contribute to increased food intake by favoring the immediate hedonic reward of eating at the expense of the long-term health gains of being normal weight; in contrast, the excessive worry found in generalized anxiety disorder may prevent individuals from excessive food intake having the potential of social and physical impairments.

Use of antidepressants, drug and alcohol abuse were not associated with being overweight. As expected all indicators of physical

activity and demographic variables such as socioeconomic status, educational level, parental income and family history of weight problems were related to being overweight. However, these variables did not influence importantly the associations between psychopathology and being overweight. The association between the rate of weight gain and frequency of sports activity is consistent with studies in obese subjects (Pavlou *et al.* 1989; Andersen *et al.* 1999) generalizing it to a non-clinical population.

Information on the causality of the associations between psychopathology and being overweight has clinical and scientific importance because it might provide insight on novel therapeutic approaches. For example, the effectiveness of treatment for weight problems is limited, and demonstrating a causal relationship between psychopathology and increased weight gain associated with clinically significant weight problems might encourage efforts to treat psychiatric conditions as a means of reducing weight-related morbidity. Given the high prevalence rates of binge eating and atypical depression as defined in this study, the impact of treatments for psychiatric conditions leading to weight gain on weight-related morbidity might be considerable.

Previous studies suggest that the causal relations between psychopathology and weight problems are complex. There is evidence that psychopathology and weight problems may share common genetic factors: results of a twin study showing an association between atypical depression and BMI suggested that familial/genetic factors influencing the vulnerability to atypical depression also influence the vulnerability to obesity (Kendler *et al.* 1996); melanocortin 4 receptor gene mutations that have been implicated in the development of obesity showed strong associations with binge eating (Branson *et al.* 2003); and familial aggregation of aggressive traits and increased body mass have been reported (Black *et al.* 1992; Pine *et al.* 1996). There is also evidence for the influence of psychosocial factors operating during critical periods in childhood and adolescence on the development of overweight and obesity; specifically, psychosocial adversities, conduct disorder symptoms and major depression during childhood have been associated with increased risk for weight problems during adulthood (Lissau & Sorensen, 1994; Pine *et al.* 1997, 2001). Finally, there is preliminary evidence that obesity may predict the development of major depression (Roberts *et al.* 2000). Because data on childhood psychopathology and on the familiality of psychiatric disorders were not included in this study we do not draw any conclusion about the causality of the associations presented in this paper.

This study has several methodological limitations that need to be addressed: Height and weight were examined by self-report; the sample was a single age cohort; the attrition rate was 38%; the sampling method to increase the probability of psychiatric disorders reduces the generalizability of the results; the definition of being overweight as having a BMI above 25 was relatively stricter for females than for males. However, the strengths of this study render these data qualified to address the questions of this study: The sample was community-based; the study design was longitudinal over 20 years; experienced clinical interviewers administered the interviews; the definition of being overweight was relevant regarding weight-related morbidity.

In summary, this study shows relatively strong associations between eating-related and aggressive psychopathology and being overweight. Atypical depression and binge eating defined as having at least for eating binges a year were associated with both, increased weight gain and clinically significant weight problems. Given that overweight an obesity are major health problems, and that atypical depression and binge eating as defined in this study show high prevalence rates, these findings encourage further studies on the causality of the psychopathology-overweight associations that might provide insight on novel preventive approaches with considerable clinical impact. The negative association between generalized anxiety disorder and being overweight needs confirmation by further studies and raises questions about the protective properties of psychiatric conditions.

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