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RELATIONSHIP OF BODY MASS INDEX TO MORBIDITY IN YOUNG ADULTS

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Introduction.

1. The health consequence of overweight is an issue of considerable interest at the present time (Royal College of Physicians Report on Obesity, 1983). Concern is growing that the proportion of the population defined as overweight is increasing and that this will have serious implications for health. However, most of the evidence has been based on data from insurance companies. Blackburn and Parlin (1966) have suggested that the insured population is highly selected and atypical and that indicators of health and obesity are unreliable. Furthermore, the apparent increase in the proportion of the population classified as overweight may reflect changing social values and definitions. Whilst it has been recognised that there are important health risks associated with gross obesity, the extent to which overweight or moderate obesity contributes to ill health remains controversial.

2. The prevalence of underweight, overweight and obesity and associated health risks in young adults can be ascertained from the recent follow-up of the National Child Development Study (NCDS4). At the age of 23 data were collected on the social and economic circumstances, health and height and weight of cohort members. Data previously collected in this study would also allow an examination of the development of obesity. Other studies have shown the influence of social and economic factors (Garn et al, 1982) and this suggests that, although there is likely to be a genetic component (Garrow 1981), the development of obesity may be to some extent, preventable.

3. Therefore, the specific aims of the present study are to provide preliminary analysis of:

   a) the prevalence of underweight, overweight and obesity,

   b) reported health problems in these weight groups,

   c) the distribution of bodysize according to social, regional and economic groups

   amongst a nationally representative sample of young people. Suggestions for further analyses are also included.

4. Since there are no direct measures of fatness available in this study an index based upon height and weight has been used. Therefore, the analysis is preceded by a brief discussion of the measures, categories, and quality of the height and weight data.

Definition of weight categories

5. The body mass index (BMI) or Quetelet index is commonly used as a crude indicator of the body's fat content in adults. The index is derived by dividing weight in kilograms by height in metres^2. The Royal College of Physicians Report on Obesity (1983) has defined the acceptable weight range for men as a BMI value of 20.1 to 25.0 and for women as 18.7 to 23.7. Furthermore a BMI value greater than 30.0 for men and 28.6 for women was defined as obese. In the present analysis the category of overweight includes all of those with a BMI value greater than the upper limit of acceptable weight and below the cut-off values for the obese category, and underweight includes all those who are below the lower limit of the acceptable weight range.

Quality of measures.

6. The limitations of the measures used in this analysis fall into three main categories:

   a) those relating to the use of BMI as an index of thinness and fatness,

b) the arbitrary classification of BMI's into the four categories, underweight, acceptable weight, overweight and obese.

c) the use of self-reported height and weight.

7. Skinfold thicknesses provide an accurate measure of an individual's bodyfat content compared with indices based upon height and weight (Garrow, 1983). However, the BMI, which relies on relatively simple data (ie. height and weight) can be used in large populations. It is known that BMI overestimates fatness amongst those with muscular, athletic builds, and very tall and very small groups may be misrepresented. The analysis of NCDS data is, therefore, subject to these limitations. However, this may not invalidate the use of the data for specific purposes. For example, comparisons of prevalence of underweight, overweight and obesity in the 1946 (NSHD) and 1958 (NCDS) cohort studies may be acceptable since the data has been collected and analysed in a similar manner in both studies and it is unlikely that systematic differences have occurred.

8. Whilst arbitrary cut-off values (based on those given in the Royal College Report on Obesity, 1983) have been used in these preliminary analyses for the purpose of simplicity, it would be possible to use the BMI as a continuous variable in some future analyses.

9. The height and weight values of 23 year old men and women in NCDS4 were self-reported. The inaccuracies which resulted from reported measurements in the 1946 cohort study underestimated the most severe degrees of overweight and underweight (Marmot et al, 1980), whereas others have claimed self-reported heights and weights to be valid and reliable (Stewart and Brook, 1983). However, unlike many other studies in which height and weight data are reported, NCDS is a longitudinal study which presents an opportunity for limited data editing.

10. Ninety-three percent of women reported their 23 year height to within 5 cms of their measured 16 year height. By the age of 16 most women would have stopped growing and so the reported heights of the remaining seven percent were checked for coding errors and implausible values. For men data-editing was less comprehensive since they had not achieved their mature height at 16 and editing was limited to reported decreases in height between 16 and 23. Where appropriate errors and implausible values were corrected; data editing is described in Appendix A. Although the tables shown in the present paper preceded data editing, it is not likely that the associations described will be affected. However, a corrected file is now available for further analyses.

Prevalence of underweight, overweight and obesity

11 Ninety-eight per cent of men (6130) and 98% of women (6146) reported both their height in feet and inches and their weight in stones and pounds. These measurements were converted into metric equivalents, from which BMI values were calculated. Table 1 shows the distribution of BMI values divided into four categories, underweight, acceptable weight, overweight and obese. The data for NCDS4 are shown with comparable data from the 1946 cohort study (Braddon, unpublished) and the Office of Population Censuses and Surveys'study of heights and weights (Obesity Report, 1983). Data for women in the OPCS study were not available for comparable categories. Whilst the OPCS study was based on measured heights and weights, both cohort studies were based on self-reported information.

Table 1: Percentage population defined as underweight, overweight and obese in three national surveys.

	BMI Range	NCDS4 (Age 23) (n=6130)	NSHD (Age 20) *	NSHD (Age 26) *	OPCS (Age 20-24) (n=527)**
Men					
Underweight	<20	10	12	8	)
Acceptable weight	20.1-24.9	70	74	67	) 78)
Overweight	25.0-29.9	18	13	22	19
Obese	>30	2	1	3	3
Women		(n=6148)			
Underweight	<18.7	10	10	8	*
Acceptable weight	18.7-23.7	68	71	68	*
Overweight	23.8-28.6	18	16	20	*
Obese	>28.6	4	3	4	*

NSHD = National Survey of Health and Development (1946 Cohort Study)

**Nos from OPCS Study are approximate only.

* data not available.

12. The prevalences of underweight, overweight and obesity in NCDS4 at age 23 are consistent with the trends in prevalence from age 20 to 26 in the NSHD (1946 cohort). Thirteen per cent of men in the NSHD were overweight at age 20, and 22 per cent at 26, whereas in NCDS4, at age 23, 18 per cent of men were overweight. The percentage of obese men increased from one per cent at 20 to three per cent at 26 in NSHD and in NCDS4 at 23, two per cent were obese. However, there was a slightly higher proportion of men in the OPCS study classified as obese (3% for men aged 20 to 24) which may be accounted for by sampling error resulting from the smaller numbers in this study compared with the two cohort studies or by more accurate measurement of heights and weights.

13. More women in NCDS4 compared with men were classified as obese, four per cent and two per cent respectively, although similar proportions were underweight and overweight. There was a similar percentage of women classified as obese at age 20 (3 per cent in NSHD) 23 (4 per cent in NCDS4) and 26 (4 per cent in NSHD).

14. Ten per cent of the men and 10% of the women in NCDS4 had BMI values below the acceptable weight range. In the 1946 cohort the proportion underweight decreased with age, from 12 per cent to 8 per cent for men aged 20 and 26, and 10 per cent to 8 per cent amongst women aged 20 and 26.

15. Data from the two cohort studies have previously been used to assess the prevalence of obesity in childhood (Peckham et al, 1983). There was a higher prevalence of obesity at the age of 7 in the 1958 study compared with the 1946. However, this difference disappeared in adolescence. A comparison of the two cohorts in young adulthood suggests that there have been no large increases in the prevalence of overweight and obesity over the twelve years separating the two cohorts. The distribution of BMI between the four categories shown in Table 1 is consistent with increasing obesity with age but not over time. It is possible, however, that over the 12 year period small changes in the prevalence of overweight and obesity have occurred which are not immediately evident here because data have not been available for the same ages. More recently, data on the weight of NCDS cohort members at the age of 26 have been collected[1]. Further analyses of these and earlier data could be used to establish whether, in fact, there have been any changes in the proportion of young people who are overweight.

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1 Cohort members received a short questionnaire at the age of 26 which asked their current weight. These data are not yet available for analyses.

16. Table 2 shows the prevalence of underweight and overweight amongst NCDS4 members according to respondents' own assessments. Compared with the BMI categories, the percentage of men and women who rated themselves as overweight was greater. Whilst 17 per cent of men were overweight according to the BMI, 28 per cent rated themselves as 'slightly overweight'; and for women 18 per cent were overweight compared with 38 per cent who assessed themselves as 'slightly overweight'.

Table 2: Comparison of body mass index and self-rated bodysize in NCDS4.

Respondent's Rating	% (N)	% (N)	% (N)	% (N)	% (N)
Men BMI Range	<20 (n=610)	20.1-24.9 (n=4273)	25.0-29.9 (n=1073)	>30 (n=144)	TOTAL (n=6100)
'Underweight'	65 (390)	15 (648)	1 (7)	1 (1)	17 (1046)
'Right weight'	35 (212)	63(2694)	19(200)	2 (3)	51 (3109)
'Slightly over-weight'	1 (8)	22 (919)	69(745)	33 (47)	28 (1719)
'Very overweight'	0	- (12)	11(121)	65 (93)	4 (226)
Women BMI Range	<18.7 (n=589)	18.7-23.7 (n=4143)	23.8-28.5 (n=1119)	>28.6 (n=268)	TOTAL (n=6119)
'Underweight'	49 (290)	5 (208)	- (3)	- (1)	8 (502)
'Right weight'	49 (289)	56(2320)	4 (42)	3 (7)	43 (2658)
'Slightly over-weight'	2 (10)	38(1571)	63(705)	17 (45)	38 (2331)
'Very overweight'	0	1 (44)	33(369)	80(215)	10 (628)

17. The discrepancy between the perceived (self-rated) and objective (BMI) categories varied; thus, 80 per cent of obese women (BMI) rated themselves as 'very overweight' but only 49 per cent of underweight women (BMI) rated themselves as underweight. There was less variation amongst men, between 63 per cent and 69 per cent perceived themselves as belonging to the corresponding objective category. It is interesting that whilst women were more likely to rate themselves as overweight compared with the objective measure, more men rated themselves as underweight: 17 per cent of men perceived themselves to be underweight compared with 10 per cent classified as such by the BMI. A similar proportion of women was underweight according to either measure.

18. Stewart and Brook (1983) reported discrepancies between objective and perceived measures of overweight in the USA: there being more people who perceived themselves to be overweight, especially amongst women. In societies in which emphasis is placed upon a slim appearance it is likely that such discrepancies will arise from the effect of social values upon the individuals' concept of ideal bodysize. In addition, discrepancies between the two indices of bodysize presented here may arise through the use of BMI as an objective measure. Some of the problems associated with the BMI have been described previously (paragraph 7).

19. The relationship between self-rated bodysize and health may be of considerable interest in future analyses. However, the tables which follow are based upon the BMI categories.

Morbidity and bodysize.

Self-assessment of health

20. Table 3 shows a comparison of body mass index categories and self-assessed health. Men and women who were within the acceptable weight range were most likely to describe their health as "excellent", 51 per cent and 44 per cent respectively. There was a higher percentage of men who rated their health as "fair" or "poor" amongst those who were overweight (10 per cent), underweight (13 per cent) and obese (18 per cent), compared with men within the acceptable weight range (7 percent). The same trend was apparent amongst women, with 9 per cent of those within the acceptable weight range describing their health as "fair" or "poor", compared with 12 per cent of the overweight, 14 per cent of the underweight and 23 per cent of the obese.

Table 3. Comparison of body mass index and self-assessed health

Respondent's assessment of own health	BMI Weight category* Under weight % (N)	Acceptable weight % (N)	Over weight % (N)	Obese % (N)
Men				
Excellent	42 (260)	51 (2204)	43 (462)	22 (32)
Good	45 (278)	42 (1796)	47 (505)	60 (86)
Fair	11 (68)	6 (265)	9 (100)	17 (24)
Poor	2 (10)	1 (25)	1 (11)	1 (2)
Women				
Excellent	42 (251)	44 (1821)	37 (417)	30 (80)
Good	44 (263)	47 (1957)	51 (577)	48(129)
Fair	12 (71)	8 (345)	11 (121)	20 (53)
Poor	2 (9)	1 (33)	1 (10)	3 (7)

* see table 1 for definitions.

21. More specifically, cohort members described their health in terms of: conditions for which they required regular medical supervision at the time of the interview, hospital admissions since the age of 16, and longstanding illness and disability. In addition they were asked if they had had migraine or sick headaches, epilepsy, asthma or wheezy bronchitis, eczema, hayfever, accidents, emotional or psychological problems, and respiratory symptoms (based on those used by the MRC Committee on the Aetiology of Chronic Bronchitis, 1960). A preliminary analysis of responses to these questions was given in Working Paper No. 22.

22. Table 4 shows rates per 1000 men and women who had conditions needing regular medical supervision at the time of the interview, and of those who had been admitted to hospital since the age of 16. The rates were higher for women compared with men. Rates are shown according to the four BMI categories used previously. Amongst men there was a higher rate of

Table 4 Morbidity and bodysize.
(prevalence rates per 1,000 population).

BMI Category	Number	Medically supervised illness Rate	(Number)	Hospital admissions* Rate	(Number)
MEN					
Underweight	(616)	54	(33)	174	(107)
Acceptable weight	(4292)	50	(215)	174	(748)
Overweight	(1078)	50	(54)	196	(213)
Obese	(144)	97	(14)	194	(28)
WOMEN					
Underweight	(594)	101	(60)	327	(194)
Acceptable weight	(4158)	84	(351)	284	(1181)
Overweight	(1125)	98	(110)	326	(367)
Obese	(269)	119	(32)	390	(105)

(BMI categories are defined in table 1)

* Hospital admissions cover the ages 16 to 23, they are therefore period prevalence rates.

medically supervised illness, amongst the obese (97 per 1000) compared with other weight groups, and they also experienced, along with those who were overweight, a higher rate of hospital admissions. Similarly, obese and overweight women had higher rates of medically supervised illness (119 and 98 per 1,000 respectively) and hospital admissions (390 and 326 per 1,000) compared with women within the acceptable weight range. Furthermore, the rates for women who were underweight were similar to those who were overweight for both medically supervised conditions and hospital admissions.

23. The rates described previously were presented without reference to reported conditions. However, conditions have been coded using the International Classification of Diseases (ICD) 9th revision (1977) and it is possible to investigate whether there are particular problems which account for the difference in admission and supervision rates between the four groups. Tables 5 and 6 show (seven-year) period prevalence rates per 1000 population of reported health problems for the four BMI categories and for women and men separately. The health problems included in these tables are those reported as limiting longstanding illnesses, those for which regular medical supervision was necessary and hospital admissions (Working Paper No. 22). Tables 5 and 6 also show whether there was a statistically significant association between the reported condition and the weight categories.

24. Table 5 shows that 538 (9 percent) women had experienced a complication during pregnancy or birth, and considering the age of the cohort, it is not surprising that this was the most common cause of admission of women to hospital. The rates also varied according to BMI group, from 167 per 1000 amongst obese women to 74 for those who were underweight. This was a statistically significant difference ($p<0.001$). There was also an association between BMI group and women who reported mental disorders (commonly depression, anxiety and nerves); endocrine, nutritional, metabolic and immunity disorders (mainly diabetes); symptoms (such as abdominal pain, breathlessness, headaches and nausea) and disorders of blood and blood-forming organs (usually anaemia) which were statistically significant. Overall there was a general trend of higher rates for women above and below the acceptable weight ranges compared with those within this range.

Table 5: Period (seven-year) prevalence of reported health problems amongst women within BMI categories (rates per 1,000 population)

ICD Category[2]	(N)	BMI Weight category[1] Under weight Rate(N)	Acceptable weight Rate(N)	Over-weight Rate(N)	Obese Rate(N)	Chi-squared value (DF=3)
Infectious	(67)	12 (7)	10 (43)	13 (15)	7 (2)	1.08
Neoplasms	(40)	5 (3)	7 (30)	6 (7)	0 (0)	2.29
Endocrine, Nutritional, Metabolic & immunity	(58)	8 (5)	7 (31)	12 (13)	33 (9)	18.96***
Blood and blood-forming organs	(44)	17(10)	6 (26)	5 (6)	7 (2)	8.83*
Mental disorders	(169)	44(26)	21 (87)	36 (41)	56 (15)	24.01***
Nervous and sense organs	(140)	24(14)	23 (95)	18 (20)	41 (11)	5.25
Circulatory system	(102)	20(12)	15 (61)	22 (25)	15 (4)	3.64
Respiratory	(260)	40(24)	39(164)	52 (59)	48 (13)	4.00
Digestive	(387)	61(36)	61(255)	70 (79)	63 (17)	1.25
Genitourinary	(383)	84(50)	58(241)	69 (78)	59 (16)	7.15
Complications of pregnancy & birth	(538)	74(44)	82(341)	96(108)	167 (45)	25.37***
Skin and sub-cutaneous tissue	(168)	19(11)	29(121)	28 (32)	15 (4)	3.85
Musculoskeletal & connective tissue	(149)	25(15)	24(101)	24 (27)	22 (6)	0.07
Congenital anomalies	(43)	13 (8)	6 (23)	6 (7)	19 (5)	10.16*
Poisoning	(108)	20(12)	16 (67)	17 (19)	37 (10)	6.77
Operations & investigations	(499)	94(56)	77(322)	85 (96)	93 (25)	2.90
Symptoms	(162)	39(23)	22 (91)	31 (35)	48 (13)	12.83**

* Significant, $p<0.05$ ** Significant, $p<0.01$ *** Significant, $p<0.001$.

N.B. It must be borne in mind that in conducting a large number of significance tests some of them will be significant purely by chance.

1. See Table 2 for definitions and numbers in each group. (It was not possible to calculate BMI values for 122 women).

2. See paragraphs 23 to 25 and Working Paper No. 22 for description.

Table 6. Period (seven-year) prevalence of reported health problems amongst men, within BMI categories (rates per 1,000 population).

ICD Category[2]		BMI Weight Category[1]				
	(N)	Under-weight Rate(N)	Acceptable weight Rate(N)	Over-weight Rate(N)	Obese Rate(N)	Chi-squared value (DF=3)
Infectious	(89)	23(14)	14 (61)	11(12)	14(2)	3.80
Neoplasms	(19)	6 (4)	3 (14)	1 (1)	0(0)	4.43
Endocrine,Nutritional Metabolic & immunity	(45)	6 (4)	6 (24)	9(10)	49(7)	36.07***
Blood and blood-forming organs	(11)	2 (1)	2 (9)	0 (0)	7(1)	4.3
Mental disorders	(92)	26(10)	12 (52)	19(20)	28(4)	9.94*
Nervous and sense organs	(206)	54(33)	30(129)	36(39)	35(5)	9.45*
Circulatory system	(47)	5 (3)	8 (33)	9(10)	7(1)	1.01
Respiratory	(200)	31(19)	31(133)	40(43)	35(5)	2.25
Digestive	(329)	54(33)	54(230)	58(62)	28(4)	2.22
Genitourinary	(48)	8 (5)	8 (36)	6 (6)	7(1)	0.90
Skin and subcut-aneous tissue	(180)	24(15)	28(120)	34(37)	56(8)	5.26
Musculoskeletal & connective tissue	(174)	29(18)	26(110)	39(42)	28(4)	5.57
Congenital anomalies	(33)	6 (4)	5 (20)	8 (9)	0(0)	3.11
Poisoning	(54)	11 (7)	9 (39)	6 (7)	7(1)	1.22
Operations and investigations	(297)	45(28)	49(211)	52(56)	14(2)	4.18
Symptoms	(122)	24(15)	20 (85)	19(20)	14(2)	0.99

*Significant, $p<0.05$ **Significant, $p<0.01$ ***Significant, $p<0.001$.

NB. It must be borne in mind that in conducting a large number of significance tests some will be significant purely by chance.

1. See table 2 for definitions and numbers in each group. (it was not possible to calculate BMI values for 140 men).

2. See paragraphs 23 to 25 and Working Paper No. 22 for description.

25. Amongst men there was also an association between the BMI groups and mental disorders and also endocrinological disorders which was consistent with that described above for women (Table 6). In addition there was a higher rate (54 per 1000) for those with nervous and sensory disorders amongst those who were underweight, compared with 30 per 1000 amongst those within the acceptable weight ranges.

26. However, for both men and women there were particular health problems (for example, infectious diseases) for which comparison with weight categories may not be meaningful because it is unlikely that a relationship exists between bodysize and health. There were other groups where numbers were very small (for example, neoplasms; disorders of blood and blood-forming organs). Also, there was a further difficulty in comparing BMI at the age of 23 with reported health problems covering the seven-year period from the age of 16 to 23. Notwithstanding these problems, there were some categories for which the association with bodysize was consistent for both men and women (eg.mental disorders), or for which there have been relationships previously suggested by other research (eg. complications during pregnancy and birth). These groups warrant further investigation and are discussed below.

BMI and complications during pregnancy and birth.

27. Table 5 shows the prevalence rates for women with complications related to pregnancy or childbirth according to BMI categories. All of these women had been admitted to hospital. A large number of admissions were for miscarriage or abortion leaving 235 women who had experienced other problems, such as hypertension complicating pregnancy or birth. Prevalence rates for these conditions for the four BMI categories are shown in Table 7. The rates varied from 97 per 1000 to 26, with the risk of obese women reporting complicating conditions during pregnancy or birth of 3.7 times that of women within the acceptable weight range. The risk to overweight women was also raised, with a relative risk of 1.5 compared with 1.0 for women in the acceptable weight range, but there were similar prevalence rates of complications during pregnancy and birth for

Table 7: Prevalence rates and relative risk of complication during pregnancy and birth, infertility**, and miscarriage for BMI categories.

BMI category	Rate*	(N)	Relative Risk	95% Confidence Intervals.
a) Complications during pregnancy (N=235).				
Underweight	27	(16)	1.0	(0.6-1.7)
Acceptable weight	26	(110)	1.0	
Overweight	39	(44)	1.5	(1.1-2.1)
Obese	97	(26)	3.7	(2.4-5.5)
b) Infertility** (not able to have children) n=83				
Underweight	17	(10)	1.7	(0.3-3.3)
Acceptable weight	10	(43)	1.0	
Overweight	19	(21)	1.8	(1.1-3.1)
Obese	33	(9)	2.3	(1.6-6.6)
(Not sure if able to have children) n=127				
Underweight	30	(18)	1.8	(1.1-3.0)
Acceptable weight	18	(72)	1.0	
Overweight	28	(31)	1.6	(1.1-2.4)
Obese	22	(6)	1.3	(0.6-3.1)
c) Miscarriage (n=392)				
Underweight	84	(50)	1.6	(1.2-2.2)
Acceptable weight	53	(219)	1.0	
Overweight	80	(90)	1.5	(1.2-1.9)
Obese	123	(33)	2.3	(1.7-3.3)

* (Seven-year) period prevalence rate per 1000 population
** Cohort members were asked if they were able to have children. In addition to 83 women who were not able to have children, 127 were not sure.

Calculation of relative risks: the risks for the underweight, overweight and obese categories have each been compared with that for women in the acceptable weight range.

underweight women and those within the acceptable weight range. These findings are consistent with the report of Peckham and Christianson (1971) in which pre-pregnancy fatness was related to obstetric complications. They found the incidence of toxemia amongst the heaviest 10 per cent of their sample was 25 times that in the lowest 10 per cent.

28. Table 7 also shows the prevalence rate for women who reported that they were unable to have children and those who were unsure. The lowest rates were reported by those in the acceptable weight range: 10 per 1000 of these women said that they were not able to have children and 18 per 1000 were not sure; compared with 33 and 22 per 1000 respectively amongst obese women.

29. Six per cent of women reported that they had had a miscarriage. A comparison of the period (seven-year) prevalence rates by weight category showed that there was an increased risk of experiencing a miscarriage for women who were underweight, overweight and obese compared with those within the acceptable weight range (Table 7). These differences were significant at the 5 per cent level but most importantly the increase in the rates was consistent: 53 per 1000 women in the acceptable weight range had miscarried, 123 per 1000 obese women had, with an intermediate value, 80 per 1000 amongst overweight women.

30. Women who were underweight had a similar risk of miscarriage or 'infertility' as those who were overweight, but not as great as obese women (Table 7).

31. It is important to stress that these are preliminary analyses only, in which other factors which are likely to affect reproductive health have not been taken into account. Obviously, severe physical disability, fertility of the partner and social class differences in child bearing (eg. age of first pregnancy, smoking during pregnancy) may influence the associations shown here and further analyses should take such factors into account. However, others have related

bodysize to differences in fertility factors. In a survey of 26,638 20 - 40 year old women in the USA, Hartz et al (1979) showed that abnormal ovulation, menstrual abnormalities and excess hair growth were associated with obesity. These authors suggested that their findings may be explained by recent demonstrations by others that obesity is associated with hormonal imbalances.

32. Data from NCDS4 suggests that there may be an association between bodysize and reproductive health. Longitudinal comparisons of bodysize at 16 (and previously) and health outcomes at 23 would be especially valuable since there is a lack of published data on this topic.

BMI and psychological problems.

33. The period (seven-year) prevalence rates for mental disorders shown in Tables 5 and 6 represent those cohort members who reported that they had been admitted to hospital or received regular medical supervision for conditions such as depression, 'nerves' or anxiety. There appears to be an association between BMI category and reported mental disorders: there being higher rates for underweight, overweight and obese men and women compared with those within the acceptable weight ranges.

34. However, cohort members were also asked specifically if they had had any emotional or psychological problem between the ages of 16 and 23 for which they had received specialist help. This information has been amalgamated with that in Tables 5 and 6 in order to identify the total number of cohort members who reported a particular psychological or emotional problem[1].

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[1] Computed with assistance from Raja Iyer.

35. Table 8 shows five psychological categories for men and women combined. Further subdivision is impractical because of the small numbers in some groups and the difficulties of precise classification with self-reported data. Also, it has been necessary to include those who had taken an overdose as a separate category when further details were not available.

36. However, Table 8 shows that fewer men and women within the acceptable weight ranges had reported a neurotic or personality disorder (prevalence rate = 36 per 1000 population) compared with those who were underweight, overweight or obese (prevalence rates = 60, 44 and 56 per 1000 respectively). Similarly, there were more underweight, overweight and obese cohort members than expected amongst those who had taken an overdose. In contrast, overweight and obese men and women tended to be over-represented amongst the mentally retarded, and in the remaining psychological category ('other problems') those who were underweight had the highest prevalence rate of 12 per 1000 population.

Table 8: Prevalence rates and relative risk of psychological and emotional problems for BMI categories.

BMI Category	Psychological category# Rate per 1000 population.	(N)	Relative risk	95 Per Cent Confidence intervals
a) Psychotic conditions+ (n = 13)				
Underweight	2	(2)	1.8	(0.4-8.2)
Acceptable weight	1	(8)	1.0	
Overweight	1	(2)	1.0	(0.2-4.5)
Obese	2	(1)	2.6	(0.3-20.8)
b) Neurotic and personality disorders* (n = 492)				
Underweight	60	(73)	1.7	(1.3-2.2)
Acceptable weight	36	(300)	1.0	
Overweight	44	(96)	1.2	(1.0-1.5)
Obese	56	(23)	1.6	(1.0-2.4)
c) Mental retardation (n = 23)				
Underweight	2	(2)	1.2	(0.3-5.2)
Acceptable weight	1	(12)	1.0	
Overweight	3	(6)	1.9	(0.7-5.1)
Obese	7	(3)	5.1	(1.5-18.1)
d) Overdose (n = 94)				
Underweight	9	(11)	1.2	(0.7-2.4)
Acceptable weight	7	(6)	1.0	
Overweight	6	(14)	0.9	(0.5-1.5)
Obese	17	(7)	2.3	(1.1-5.0)
e) 'Other' ** (n = 105)				
Underweight	12	(15)	1.4	(0.8-2.5)
Acceptable weight	9	(74)	1.0	
Overweight	6	(13)	0.7	(0.4-1.2)
Obese	7	(3)	0.8	(0.3-2.6)

+ includes ICD codes 290 to 299, schizophrenia, manic depression and other psychoses.
* includes ICD codes 300 to 316, anxiety and depression
** includes sleep disorders, tics, post-natal depression etc
# 21 individuals who had seen a specialist for a psychological problem gave inadequate details and they are not included in this table.
For calculation of relative risks see footnote to Table 7.

37 So far, the index used to assess psychological health has been self-reported conditions for which treatment had been sought. NCDS4 includes another measurement, the Malaise Inventory, with which BMI was compared. The Malaise Inventory consists of 24 questions on physical and mental manifestations, or symptoms, of psychiatric disturbance (Appendix B). This measure was developed by the Institute of Psychiatry from the Cornell Medical index, and whilst the instrument alone could not be used to diagnose clinical depression, it has been used as a screening method to indicate the likelihood of a psychiatric disorder (Rutter et al, 1970). The relationship between malaise scores and reported psychological problems is given in Appendix C.

Table 9. Malaise inventory scores within BMI categories.

		Malaise scores.			
BMI Categories+	(N)	Mean	S.D.	'Depressed'#	Chi-squared (DF=3)
Men					
Underweight	(616)	2.3	2.8	(8%)	
Acceptable weight	(4285)	1.9	2.4	(5%)	
Overweight	(1072)	2.3	2.7	(8%)	18.57***
Obese	(143)	2.3	2.7	(7%)	
Women					
Underweight	(591)	3.9	3.5	(20%)	
Acceptable weight	(4148)	3.2	3.0	(14%)	
Overweight	(1120)	3.8	3.4	(18%)	40.34***
Obese	(267)	4.4	3.8	(24%)	

+ BMI categories are defined in Table 1.

'Depressed' is defined as having a malaise score of 7 or more.

*** Significant, $p<0.001$.

38. The 24 items in the Malaise Inventory were scored so that each positive item was given a value of one. Theoretically, the higher the score (up to the maximum of 24) the greater the likelihood of depression. Table 9 shows mean malaise scores for the four BMI categories. Although women had higher mean scores compared with men, for both sexes those within the acceptable weight range had lower mean scores compared with the other weight groups. Amongst women the mean score ranged from 3.2 for those within the acceptable weight range to 4.4 for the obese. The difference in the means was less for men, ranging from 1.9 for those within the acceptable weight range to 2.3 in the three remaining weight categories.

39. The major difficulty in comparing mean malaise scores is that the distribution of scores is highly skewed. Others[1] have used a cut-off value to indicate possible depression. Table 9 shows the percentages of men and women within each weight group who had a malaise score of 7 or more. Twenty-four per cent of obese women and 20 percent of women who were underweight were classified as 'depressed', compared with 14 percent of those within the acceptable weight range. There were smaller differences between the percentage of men in the four weight groups who were 'depressed'. The difference between the percentage depressed and BMI group was statistically significant for both men and women ($p<0.001$).

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1 Rutter et al (1976) reported that women with a psychiatric disorder were more likely to score above a cut-off value of 7 than those without psychiatric disorder. Richman (1978) also reported rising mean scores and proportions at or above cut-off of 8 for mothers with psychiatric disorder and increasing severity of functional impairment. Hirst and Bradshaw (1983) reported only moderate correlations with other measures of stress.

40. In a middle-aged sample of the general population, Crisp and McGuiness (1975) examined the relationship between aspects of psychological status and obesity. They reported that obese people (men who were 20 percent and women who were 40 percent above standard weight-for-height) were much less anxious and in the case of men, much less depressed than the rest of the population. There were no statistically significant differences between the mean depression scores of obese and 'normal' women. However the findings from NCDS4 suggest that proportionately more of the obese women, and to a lesser extent obese men, were likely to be 'depressed' compared with their peers within the acceptable weight range.

41. Possible explanations for the different findings in the two groups include the age of the participants. Crisp and McGuiness (op cit) studied a middle-aged sample of the general population, whereas all members of NCDS4 were aged 23 at the time of interview. Bruch (1974) and Stewart et al (1983) have suggested that adolescence and young adulthood are periods of particular weight consciousness. Also, different measures of 'depression' were used in the two studies (Crisp and McGuiness had used the Middlesex Health Questionnaire). Others have used the Cornell Medical Index (upon which the Malaise Inventory was based) and reported twice the prevalence of 'emotional disturbance' among obese women compared with a normal population (Silverstone and Solomon, 1965).

42. The relationship between psychological status and bodysize is complex. Not all members of NCDS4 who were obese were 'depressed' compared with those in the acceptable weight range. Meanwhile, there are virtually no data showing a causal relationship between emotional disturbance and obesity. In future analyses of NCDS data, it will be possible to examine the role of psychological factors in the development of obesity.

BMI and other health problems.

43. Other reported health problems for which there was a statistically significant ($p<0.001$) association between prevalence (seven-year period rates per 1000 population) and BMI category include endocrine, nutritional and metabolic disorders (Tables 5 and 6). There were higher rates amongst those who were obese compared with the other weight groups for both men and women . However, this category includes individuals who were being treated for their obesity and over a third of them reported that they had diabetes which is known to be associated with obesity (Mann, 1983). This association illustrates how cross-sectional analyses can reveal the consequences of weight problems without necessarily being able to identify under- or overweight as potential risk factors in the development of disease. Longitudinal analysis of NCDS would, to some extent, overcome such problems.

44. Similarly, there was a statistically significant ($p<0.01$) association between BMI category and the period prevalence rates for women (but not men) who reported a variety of symptoms: there being a higher rate amongst the obese and underweight groups compared with the others. Again, this relationship was to be expected since this category included those who had reported eating and weight problems. However, other women had reported dizziness, breathlessness, abdominal pain, headaches etc. and further analyses would be necessary to assess whether or not underweight or overweight women experienced more of these problems compared with others.

45. Further analyses of these and other health indices, such as accidents and backache, would take social and behavioural factors into account. A preliminary discussion of the association between bodysize and measures of social position is given below.

BMI and social class, educational achievement, income and region of residence.

46. Table 10 shows the distribution of BMI within four social class[1] subdivisions, namely professional and managerial (I and II), other non-manual (IIIN), skilled manual (IIIM) and unskilled manual (IV and V). Compared with non-manual workers, there was a higher percentage of men who were overweight and obese, and a lower percentage of men who were underweight and of acceptable weight amongst all manual workers. The difference in the percentage overweight varied from 24 per cent of skilled manual to 12 per cent of professional and managerial workers; and for underweight from 8 per cent of skilled manual to 12 per cent of all non-manual.

Table 10: Prevalence (percentage) of BMI category according to social class[1]

	Social class							
	I and II		IIIN		IIIM		IV and V	
BMI Category*	%	(N)	%	(N)	%	(N)	%	(N)
Men								
Underweight	12	(149)	12	(122)	8	(197)	9	(103)
Acceptable weight	75	(948)	72	(711)	68	(1604)	68	(806)
Overweight	12	(153)	15	(144)	21	(488)	20	(244)
Obese	1	(14)	1	(13)	3	(70)	3	(40)
Women								
Underweight	10	(132)	10	(292)	7	(41)	9	(107)
Acceptable weight	71	(898)	70	(2030)	63	(347)	62	(762)
Overweight	16	(199)	17	(488)	23	(127)	23	(284)
Obese	3	(35)	4	(101)	6	(35)	7	(86)

* see table 1 for BMI values (BMI and social class was not available for 303 women and 465 men).

[1] The OPCS (1980) Classification of occupations was used to derive the social class of 96 per cent of NCDS4. Four per cent were unclassifiable. Eighty-one per cent of men and 58 per cent of women were classified according to this occupation at the time of the interview and the remainder by a previous occupation.

47. Amongst women there was a similar trend of higher percentages of overweight and obesity amongst manual workers compared with non-manual. Thus 29 per cent and 30 per cent of social class IIIM, and IV and V respectively were overweight and obese whereas only 19 per cent and 21 per cent of social classes I and II and IIIN were so classified. Conversely there was a higher percentage of women in social classes I and II and IIIN who were underweight compared with the lower social classes. Baird et al (1974) also reported a higher prevalence of overweight amongst lower social class women in London. Furthermore, previous analysis of NCDS data had shown that the higher prevalence of overweight amongst lower socio-economic groups was already apparent at the ages of 7, 11, and 16 (Peckham et al, 1983).

48. In future analyses it would be possible to investigate whether social class differences in the prevalence of overweight are changing with age or with time. This would involve a comparison of overweight in both the 1958 and 1946 longitudinal studies.

49. Social class, based on occupation, is only one index of social position, and, considering the age of the cohort, there are many limitations in the use of this index alone. However, NCDS also includes details of highest education level achieved and this may be used as an additional measure of social position.

50. Table 11 shows the prevalence of underweight, overweight and obesity within five educational qualifications groupings. There was a higher percentage of men, 78 percent, within the acceptable weight range amongst those who had attained qualifications above 'A' level standard compared with 63 percent of those who had no qualifications. Moreover, the prevalence of overweight and obesity increased from 11 percent of those with the highest qualifications to 27 percent of those with none.

51. The same trend of increasing prevalence of overweight and obesity with decreasing level of educational achievement was evident amongst women: 17 percent of those with qualifications above 'A' level were overweight or obese compared with 30 percent of women with no qualifications (Table 11). However, this trend was not as consistent for women compared with men since the lowest prevalence of overweight and obesity was found amongst those with 'A' levels or their equivalent.

Table 11: Prevalence (%) of BMI categories according to level of education achieved

	Qualifications.									
	>'A' level		'A' level*		'O' level*		<'O' level		None.	
BMI Category	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)
Men.										
Underweight	12	(135)	12	(155)	9	(149)	4	(15)	11	(162)
Acceptable weight	78	(910)	70	(945)	72	(1243)	70	(237)	63	(954)
Overweight	10	(116)	18	(236)	18	(305)	22	(74)	23	(345)
Obese	1	(12)	1	(13)	2	(40)	4	(13)	4	(66)
Women.										
Underweight	10	(115)	11	(77)	10	(220)	10	(27)	9	(155)
Acceptable weight	73	(804)	74	(510)	68	(1546)	67	(183)	62	(1114)
Overweight	15	(162)	14	(95)	18	(409)	18	(50)	23	(408)
Obese	2	(23)	1	(10)	4	(86)	5	(14)	7	(134)

* or equivalent.

Table 12: Mean weekly income1 of cohort members classified according to BMI.

BMI Category*	Men (N)	Men Mean	Men S.D	Women (N)	Women Mean	Women S.D.
		£			£	
Underweight	(576)	115.7	59.0	(571)	107.6	56.6
Acceptable weight	(4026)	126.3	62.3	(3991)	108.5	58.3
Overweight	(1027)	127.0	62.9	(1086)	99.3	50.0
Obese	(134)	111.9	61.8	(262)	84.8	45.2

* See Table 1 for definition.

52. Table 12 shows mean equivalent net family income[1] for men and women in the four BMI categories. Amongst men, those who were underweight or obese had lower mean incomes (£115.7 and £111.9 per week respectively) compared with those within the acceptable weight ranges and overweight men (£126.3 and £127.0 per week). However, amongst women, those who were obese or overweight had lower mean incomes compared with those of acceptable weight and the underweight.

53. It has been suggested that the social pressure to be slim is greater for women, for younger people, and for people with higher incomes and smaller families (Stewart and Brook, 1983). Thus Garn et al (1977) have shown a differential change in the prevalence of obesity as groups become more affluent, with young men becoming more overweight and young women, particularly if they marry into higher income families, becoming slimmer.

1 Equivalent net family income is net income adjusted to allow for the size and composition of the respondent's family (ie. respondent, spouse or partner and any children in their care) and may be taken to be a proxy measure of standard of living. Therefore, the low income of single adult families and those without children are adjusted upward because of their relatively lower requirements. Conversely, the higher incomes of married and cohabiting couples and those with children are lowered because of their relatively higher requirements. A fuller description is given in Working Paper No. 19.

54. In NCDS the differences in the prevalence of overweight and obesity between young men and women with varying levels of qualifications, occupational class and income, may be related to differences in body images between these groups. Further analyses are necessary to investigate whether there are differences in body image between different social groups and how they may be related to the development of leanness, overweight and obesity.

55. Preliminary analyses of NCDS data also suggest that there were regional variations in weight status. Table 13 shows an overall trend of higher percentage prevalence of underweight in the Southern and Eastern regions in the country and lower prevalence in the North and West. With the exception of East Anglia where numbers were relatively small, there was considerable agreement between the prevalence of underweight for men and women: in general, the regions with high prevalence of underweight for men were also high for women and similarly for those with low rates.

56. Table 13 shows that, in contrast to the regional distribution of underweight, there was an overall trend of higher prevalence of overweight and obesity in the Northern and Western regions and lower prevalence towards the South and East. The difference in the prevalence of obesity was greater than twofold for both sexes, ranging from 75 (in Wales) to 33 (in the South West) per 1000 women and 37 (in Wales) to 16 (in East Anglia) per 1000 men.

57. Regional variations in the prevalence of overweight and obesity may be accounted for by the geographical distribution of social class. However, they may also be related to such factors as regional differences in dietary habits, levels of physical activity or body image. Data for regional eating habits are available through the National Food Survey, whereas NCDS contains some information on leisure activities and perceived weight status.

TABLE 13. Prevalence (%) of underweight, overweight and obesity by region.

B.M.I Category*	Greater London	East Anglia	East Midlands	South East	South West	West Midlands	Scotland	North West	North	Wales	Yorks and Humberside.	All regions
a) Men (Number)	(713)	(188)	(389)	(1087)	(406)	(555)	(585)	(664)	(366)	(327)	(531)	(5811)
Underweight	12	18	11	12	11	10	11	10	6	7	6	10
Acceptable weight	72	64	67	71	70	69	71	72	70	62	72	70
Overweight	14	17	19	16	17	19	16	17	21	27	20	18
Obese	2	2	3	2	2	2	3	2	4	4	3	2
b) Women (Number)	(756)	(187)	(378)	(1041)	(429)	(529)	(611)	(683)	(386)	(307)	(509)	(5816)
Underweight	12	9	12	10	10	10	9	9	10	8	8	10
Acceptable weight	70	69	65	68	68	68	65	70	67	61	70	68
Overweight	15	14	19	18	19	17	22	17	19	24	18	18
Obese	4	8	4	4	3	6	4	4	5	8	4	4

* See table for BMI values.

Future work

58. The associated risks in morbidity for young men and women have been described using simple cross-sectional analyses. Multivariate techniques are necessary to determine the extent to which any increased risk for those who were underweight or overweight can be accounted for by other factors such as smoking habits or alcohol intake.

59. These data suggest that more cohort members were obese at the age of 23 than during childhood or adolescence. There were also differences in the prevalence of underweight and overweight according to social position. Future analyses would show whether the increasing prevalence of overweight and obesity was similar for all social groups or whether this varied.

60. Preliminary comparison of the 1946 and 1958 cohorts suggests that there have been no large increases in the prevalence of obesity amongst young people. Further analyses, using more recently collected data from NCDS (at age 26) would show the extent to which the proportion of young people who were overweight changed and whether this varied for different social groups.

61. Longitudinal analyses are required to establish whether particular health problems are a consequence of, or a contributing factor to, the development of underweight or overweight.

62. It would also be possible to examine the relationship between perceived and objective measures of bodysize; how these are related to health at 23; and factors (such as previous bodysize) which may be associated with the development of body image.

63. Furthermore, it would be possible to identify whether regional patterns of eating habits (as shown in the National Food Survey) were associated with the regional distribution of overweight and obesity (as shown in NCDS4).

64. Finally, the role of other possible antecedents of overweight and obesity such as earlier physical activity and emotional behaviour could be investigated.

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No.2. Initial Analyses with the Malaise Inventory (Anne Bowling)
No.19. Earnings, income and other aspects of financial circumstances of the NCDS cohort at 23 (Peter Shepherd).
No.22. Health and Health-related behaviour in NCDS4 (Christine Power).

APPENDIX A

Heights and Weight

Data Editing

The questionnaires of 834 men and 812 women were checked for coding and reporting errors in heights and weights. Individuals were selected for checking if they had extreme values (that is, greater than two standard deviations) for either height, weight or relative weight. In addition, individuals were selected if there were unlikely differences between their 16 year and 23 year height. Exact agreement between these two values was not anticipated not only because the values at 23 were self-reported, but also because small differences had occurred as a result of converting imperial values to metric at both ages. The heights and weights of 237 men and 241 women were checked because their reported height at 23 was less than their 16 year height by 5 cms (for girls) or 2 cms (for boys) or greater by 7 cms and 18 cms respectively.

The criteria which were used to accept or discard the recorded heights and weights were as follows:

No 23 year heights which were less than 16 year values by 5 cms (for girls) or 2 cms (for boys) were accepted unless the 16 year value was found to be implausible. Standard growth charts (Tanner and Whitehouse, 1972) were used to check these values. For boys, maximum increases in height of 30 cms were accepted only if puberty ratings at the age of 16 were not adult. Increases up to 10 cms were accepted for girls who had not been rated as adult at 16 and whose age of menarche was later than their fourteenth birthday.

For individuals who had reached adulthood by the age of 16 and for whom previous heights were available (at age 7 or 11) it was possible to replace implausible heights with estimated values using the standard growth charts.

A total of 9 heights at the age of 23 were discarded. Revised values were estimated for 50 men and 119 women. It was not possible to adjust weights at the age of 23, but the weights of 13 individuals not previously coded at 23 were included as a result of the edit check.

Although the heights and weights in earlier sweeps had been edited previously (Peckham et al, 1983) a small number of errors for earlier values were detected. There were 9 heights and weights errors for ages 7 and 11, and at age 16 heights and weights were corrected for 11 boys and 31 girls.

APPENDIX B: THE MALAISE INVENTORY

1. Do you often have back-ache?
2. Do you feel tired most of the time?
3. Do you often feel miserable or depressed?
4. Do you often have bad headaches?
5. Do you often get worried about things?
6. Do you usually have great difficulty in falling or staying asleep?
7. Do you usually wake unnecessarily early in the morning?
8. Do you wear yourself out worrying about your health?
9. Do you often get into a violent rage?
10. Do people often annoy and irritate you?
11. Have you at times had a twitching of the face head or shoulders?
12. Do you often suddenly become scared for no good reason?
13. Are you scared to be alone when there are no friends near you?
14. Are you easily upset or irritated?
15. Are you frightened of going out alone or of meeting people?
16. Are you constantly keyed up and jittery?
17. Do you suffer from indigestion?
18. Do you often suffer from an upset stomach?
19. Is your appetite poor?
20. Does every little thing get on your nerves and wear you out?
21. Does your heart often race like mad?
22. Do you often have bad pains in your eyes?
23. Are you troubled with rheumatism or fibrositis?
24. Have you ever had a nervous breakdown?

APPENDIX C

a) Malaise inventory scores of cohort members with reported psycological problems

Psychological problems	N.	Malaise Scores. Mean	S.D.	'Depressed'*
Psychotic conditions	12	7.2	5.3	42%
Non-psychotic disorders	473	7.0	4.4	49%
Neurotic disorders	(181)	(7.3)	(4.4)	(53%)
Depression	(248)	(7.1)	(4.4)	(51%)
Personality disorders	(16)	(4.6)	(3.4)	(31%)
Sexual deviations	(4)	(2.8)	(2.8)	(0%)
Alcohol dependence	(15)	(6.7)	(4.0)	(47%)
Drug dependence	(11)	(9.5)	(4.9)	(73%)
Anorexia Nervosa	(15)	(5.0)	(4.6)	(27%)
Mental retardation	13	6.5	3.1	67%
Overdose	95	6.9	4.3	46%
Other disorders	101	5.1	3.9	34%
Post-natal depression	(15)	(7.1)	(3.9)	(60%)
Inadequate reply	21	5.8	4.1	43%

* See table 9 (page 20) for the definition of 'depressed'.

Those categories with figures shown in brackets are sub-divisions of the larger groups.

b) Malaise inventory scores of cohort members without reported psychological problems.

	N.	Malaise Score. Mean	S.D.	'Depressed'*
No reported psychological problem	11807	2.5	2.7	9%
'Healthy'+ cohort members	1867	1.6	1.9	3%

+ defined in working paper No. 22 - as those cohort members who reported no health problems between the ages of 16 and 23.

c) Comparison of Malaise inventory score for men and women with and without reported psychological problems.

Psychological health status	Malaise Scores. Men N.	Mean	S.D.	% Depressed.	Women N.	Mean.	S.D.	% Depressed
No reported psychological problems	6011	1.9	2.3	(5%)	5796	3.1	2.9	(13%)
Neurotic disorders	58	5.6	3.9	(35%)	123	8.2	4.4	(62%)
Depression	68	6.6	4.3	(46%)	180	7.3	4.4	(53%)
Overdose	35	6.0	4.3	(41%)	60	7.4	4.3	(48%)