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Height, weight and body mass index (BMI) in psychiatrically ill US Armed Forces personnel

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Abstract

Background—In both psychiatrically ill and psychiatrically healthy adults, the connection between health and individuals' height and weight has long been examined. Specifically, research on the idea that individuals with certain body types were prone to particular psychiatric diseases has been explored sporadically for centuries. The hypothesis that psychiatrically ill individuals were shorter and weighed less than psychiatrically healthy counterparts would correspond with the neurodevelopmental model of psychiatric disease.

Method—To evaluate possible links between psychiatric illness and physique, the height, weight and BMI of 7514 patients and 85 940 controls were compared. All subjects were part of the National Collaborative Study of Early Psychosis and Suicide (NCSEPS). Patients were US military active duty personnel hospitalized for either bipolar disorder, major depressive disorder, or schizophrenia and controls were psychiatrically-healthy US military active duty personnel matched for date of entry into the service.

Results—No consistent differences in height, weight or BMI were found between patients and controls, or between patient groups. Some weak ANOVA differences were found between age at the time of entering active duty and weight, as well as BMI, but not height.

Conclusions—Unlike most previous studies that have looked at the links between height and psychiatric illness, this study of the NCSEPS cohort found that, at entry into the US Armed Forces, there were no consistent decreases in height for patients with bipolar disorder, major depressive disorder or schizophrenia compared with a large control group. Furthermore, there were no consistent differences for weight or BMI.

INTRODUCTION

The connection between health and individuals' height and weight has been examined since ancient times. Classical scholars including Hippocrates, Galen and Aristotle suggested that physical characteristics gave clues to a person's personality and health. This idea flourished during the Renaissance, culminating in serious study of symmetria (the study of body proportions), phrenology (the study of the configuration of the skull for clues to mental

faculties) and physiognomy (the study of the face and bodily carriage to establish character and mental qualities) (Ciocco, 1936).

In the early part of the 20th century, Burchard (1916), and more extensively Kretschmer (1925), examined this issue systematically. Research on this concept has continued sporadically since that time. Some (Burchard, 1916; Kretschmer, 1925; Betz, 1942; Singer *et al.* 1972; Kemali *et al.* 1976; Nopoulos *et al.* 1998), but not all (von Zerssen, 1966; Houston & Bloom, 1975; Ward *et al.* 1996), investigators found that patients with schizophrenia were shorter than controls. Patients with schizophrenia have also been found to be shorter than patients with bipolar disorder (Pivnicki & Christie, 1968). The most recent of these studies found that a group of male patients with schizophrenia were slightly shorter than a group of psychiatrically healthy male controls (177.2 cm v. 179.4 cm) (Nopoulos *et al.* 1998). Nevertheless, other factors could potentially confound this finding. Houston & Bloom (1975) found that height was lower for males with chronic schizophrenia than for controls, but that there was no difference in height between males with acute schizophrenia and controls. Von Zerssen (1966) showed that differences in body type between individuals with schizophrenia and those with bipolar disorder were due primarily to age of onset. And, it has also been argued that the total lifetime dose of neuroleptics is a confounding factor in modern studies that assess height in schizophrenia because neuroleptics can affect bone density, which in turn can lead to osteoporosis and related decrements in height (Kawai *et al.* 1999).

The neurodevelopmental hypothesis of bipolar disorder, major depressive disorder and schizophrenia (Jones & Murray, 1991; Weinberger, 1987; Brown *et al.* 1995) is in keeping with the early findings that height and weight are decreased in individuals with these disorders. A number of putative links to an array of pre- and peri-natal adverse events have been related to the subsequent development of psychiatric illness, and particularly schizophrenia. These include infections during the second trimester of pregnancy (Mednick *et al.* 1988), malnutrition during pregnancy (Susser & Lin, 1992), Rh incompatibility between the mother and foetus (Hollister *et al.* 1996) and obstetric complications (Verdoux *et al.* 1997).

The neurodevelopmental hypothesis would posit that the individuals who suffer such insults *in utero* might be shorter and weigh less both as children and as adults. One recent study found that childhood BMI (measured at age seven) was an independent predictor of schizophrenia (Wahlbeck *et al.* 2001). Most recent studies that have looked at the issue of BMI in schizophrenic individuals, however, have addressed this issue as a side effect of neuroleptics, and thus have not focused on the pre-illness measures of individuals (Allison *et al.* 1999; Coodin, 2001). One large study compared BMI in three different cohorts of schizophrenic individuals (most of whom were taking neuroleptics) and non-schizophrenic individuals. In one cohort, women with schizophrenia had a significantly higher BMI than women without schizophrenia, but in the remaining cohorts there were no differences between BMI for schizophrenic and non-schizophrenic women. In all three cohorts there were no differences in BMI between schizophrenic and non-schizophrenic men (Allison *et al.* 1999).

For this study, we assembled a cohort of 7514 men and women who were active duty personnel in the US military at the time of their first hospitalization for bipolar disorder, major depressive disorder, or schizophrenia. The cohort is part of the National Collaborative Study of Early Psychosis and Suicide (NCSEPS), an ongoing collaboration between the National Institute of Mental Health (NIMH), the US Department of Defense (DoD), and the US Department of Veterans Affairs (VA). These patient groups were compared with a large, psychiatrically healthy active duty control group.

At the time of entry into the US Armed Forces, each individual undergoes a physical examination during which height and weight are recorded. In all except a small subset of cases (10–20% are believed to have illnesses that predate their entrance into the military (unpublished data)), height and weight measures recorded at entry into the Armed Forces precede the development of a discernible psychiatric disorder in these individuals.

METHOD

The NCSEPS was approved by the NIMH Institutional Review Board. Patient information was handled through the use of assigned patient identifiers rather than identifiable personal information such as social security numbers.

The Patient Administration Systems and Biostatistics Activity (PASBA, Fort Sam Houston, Texas), provided hospitalization dates and hospital discharge diagnoses for active duty personnel. As determined by hospital discharge diagnoses, we parsed information relating to individuals who specifically had their first diagnosis for bipolar disorder, major depressive disorder, or schizophrenia in years 1980 through 1999. During this time DSM-III-R, and DSM-IV diagnostic criteria (American Psychiatric Association, 1987, American Psychiatric Association, 1994) were used by the US military. The Defense Manpower Data Center (DMDC, Monterey, California) provided height (in inches) and weight (in pounds) information for patients and controls.

All patients were in active duty in various branches of the US military at the time of first hospitalization for bipolar disorder, major depressive disorder, or schizophrenia. Diagnostic reliability was determined by an independent review of 71 Medical Boards for patients who had psychiatric hospitalizations at Walter Reed Army Medical Center (WRAMC). The last hospital discharge diagnosis almost always mirrors the Medical Boards (in our review, concordance was 100%). The Medical Board reports are usually eight or more pages in length, and reflect the consensus diagnosis of three psychiatrists based on a patient interview and chart review. These diagnoses were compared with the consensus diagnosis of two psychiatrists blind to the Medical Board diagnosis. Patients were given a diagnosis of bipolar disorder, major depressive disorder, schizophrenia or Other according to DSM-IV criteria. The kappa for inter-rater reliability was 0.84, indicating 88% agreement between the blind diagnosis and the last hospital or primary diagnosis.

All patients who entered the military between 1980 and 1999 and who were hospitalized while on active duty between 1991 and 1999 were part of the cohort. Matching criteria for controls were limited to month and year of entry into the service. For every month–year

combination for which a patient entered active duty (every month between 1980 and 1999), 2% of military entrants were randomly selected to be controls.

The patient population for this study comprised 7514 patients who were hospitalized with bipolar disorder ($N=1457$), major depressive disorder ($N=4668$), or schizophrenia ($N=1389$) while on active duty. Patients were matched with a large, psychiatrically healthy control group ($N=85\,940$). Not all patients were available for all analyses.

Consistent with previous studies in this area, analyses were conducted separately for white males, black males, white females and black females. The Hispanic and Other ethnic groups were not analysed because the number of subjects in some diagnostic groups was comparatively small and because the 'Other' group was ethnically quite heterogeneous (for example, it includes Native Americans, Asian Americans and subjects native to Guam).

Associations between height, weight, BMI and age at entry into the Armed Forces were assessed using Pearson's correlation r . Two-tailed t tests were used to establish ethnic differences, although quantitative characteristics of the different groups were compared using a two-way GLM ANOVA for all analyses, limiting the analyses to specific race/gender groups in the first four rows of Tables 1–3. Analyses were controlled for age by using age as a grouping factor at two levels: <21-year-old and ≥21-year-old. Three F tests were produced for each analysis (height, weight, or BMI): diagnostic group, age, and group by age interaction.

Caution in interpreting ' P values' is suggested as the large sample sizes make many results statistically significant without necessarily being meaningful; thus, throughout this paper, a P value of <0.01 determined statistical significance. Effect sizes are also presented so that the magnitude of the demographic group differences can be indexed to the control group. In the interest of space, not all possible effect sizes are presented; basic statistics are presented in Tables 1–3 for interested readers who may wish to compute other effect sizes. Analyses were conducted using NCSS 2000 (Number Cruncher Statistical Systems 2000, Statistical System Software for Windows, Kaysville, UT).

RESULTS

For the four gender–race combinations (white male, white female, black male, black female), no consistent differences were found between patients and controls or among the patient groups for height, weight, or BMI. The effect sizes ranged from non-existent to medium, but were not consistent in either direction. Thus, any differences are not likely to be meaningful.

For height there was no ANOVA effect for age at entry to active duty. There were, however, some weak ANOVA age effects for weight and BMI. White males, black males, and black females ages 21 and older were heavier at entry into the Armed Forces than white males, black males, and black females younger than 21. Correspondingly, white males, black males and black females ages 21 and older had a greater BMI at entry into the Armed Forces than white males black males and black females younger than 21. Mean weights and BMIs were within an average, healthy range for all groups.

DISCUSSION

Unlike most previous studies that have examined the links between height and the development of psychiatric illness, this study of the NCSEPS cohort found that, at entry into the US Armed Forces, there were no consistent decreases in height for patients with bipolar disorder, major depressive disorder or schizophrenia compared with a large control group. Furthermore, there were no consistent differences for weight or BMI.

The notion that there are quantifiable links between physique and mental illness, as posited by the neurodevelopmental model of schizophrenia and other major psychiatric disorders, is not supported by these data from the NCSEPS.

The weak ANOVA differences between age at entry and weight and BMI showed that white males, black males, and black females ages 21 and older were heavier and had correspondingly higher BMIs at entry into the Armed Forces than white males, black males, and black females younger than 21. These very small differences in weight and BMI are most likely due to physiological changes and have little relevance to the neurodevelopmental model of psychiatric illness.

This study had several major advantages. First, height and weight were recorded at a time when most of the subjects were known to be healthy and were thus not taking medications that might affect body measurements. Secondly, the subjects were from a large population with diverse backgrounds. Thirdly, the cohort was large enough that effects could be examined by gender and ethnicity.

One caveat, however, is that height and weight differences related to schizophrenia and/or bipolar disorder might be present only in patients with earliest-onset schizophrenia and bipolar disorder, and perhaps major depressive disorder. These individuals would be most likely to develop a psychiatric illness before the age of military eligibility and would be excluded from our sample. Thus, these results may not apply to a more general population of unscreened individuals.

Nevertheless, these data indicate that smaller stature is not generally a pre-morbid phenomenon in individuals with bipolar disorder, major depressive disorder or schizophrenia.

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References

- Allison DB, Fontaine KR, Heo M, Mentore JL, Cappelleri JC, Chandler LP, Weiden PJ, Cheskin LJ. The distribution of body mass index among individuals with and without schizophrenia. *Journal of Clinical Psychiatry*. 1999; 60:215–220. [PubMed: 10221280]
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders-III-R*. American Psychiatric Association; Washington, DC: 1987.
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders-IV*. American Psychiatric Association; Washington, DC: 1994.

- Betz B. Somatology of the schizophrenic patient. *Human Biology*. 1942; 14:21–47.
- Burchard, E. *Comprehensive Psychological Monographs*. Vol. 73. John Hopkins Press; Baltimore: 1916. Physique and psychosis. An analysis of the postulated relationship between bodily constitution and mental disease syndrome.
- Brown AS, Susser ES, Lin SP, Neugebauer R, Gorman JM. Increased risk of affective disorders in males after second trimester prenatal exposure to the Dutch Hunger Winter of 1944–45. *British Journal of Psychiatry*. 1995; 166:601–606. [PubMed: 7620744]
- Ciocco A. The historical background of the modern study of constitution. *Bulletin of the History of Medicine*. 1936; 4:23–38.
- Coodin S. Body Mass Index in persons with schizophrenia. *Canadian Journal of Psychiatry*. 2001; 46:549–555.
- Hollister JM, Laing P, Mednick SA. Rhesus incompatibility as a risk factor for schizophrenia. *Archives of General Psychiatry*. 1996; 53:19–24. [PubMed: 8540773]
- Houston BK, Bloom LJ. Constitutional factors, stature, and chronic schizophrenia. *Journal of Clinical Psychology*. 1975; 31:26–29. [PubMed: 1112898]
- Jones P, Murray RM. The genetics of schizophrenia is the genetics of neurodevelopment. *British Journal of Psychiatry*. 1991; 158:615–623. [PubMed: 1860016]
- Kawai M, Takei N, Mori N. Correspondence. *Psychological Medicine*. 1999; 29:753–754. [PubMed: 10405097]
- Kemali D, Polani N, Amati A. Adermatoglyphic study of 219 Italian schizophrenic males. *Clinical Genetics*. 1976; 9:51–60. [PubMed: 1248163]
- Kretschmer, E. *Physique and Character*. Harcourt Brace and Co; New York: 1925.
- Mednick SA, Machon RA, Huttunen MO, Bonett D. Adult schizophrenia following prenatal exposure to an influenza epidemic. *Archives of General Psychiatry*. 1988; 45:189–192. [PubMed: 3337616]
- Nopoulos P, Flaum M, Arndt S, Andreasen N. Morphometry in schizophrenia revisited : height and its relationship to pre-morbid function. *Psychological Medicine*. 1998; 28:655–663. [PubMed: 9626721]
- Pivnicki D, Christie R. Body build characteristics in psychotics. *Comprehensive Psychiatry*. 1968; 9:574–580. [PubMed: 5703307]
- Singer K, Chang P, Hsu G. Physique, personality and mental illness in the Southern Chinese. *British Journal of Psychiatry*. 1972; 121:315–319. [PubMed: 5073784]
- Susser E, Lin S. Schizophrenia after prenatal exposure to the Dutch hunger winter of 1944–1945. *Archives of General Psychiatry*. 1992; 49:983–988. [PubMed: 1449385]
- Verdoux H, Geddes JR, Takei N, Lawrie SM, Bovet P, Eagles JM, Heun R, McCreadie RG, McNeil TF, O'Callaghan E, Stober G, Willinger U, Wright P, Murray RM. Obstetric complications and age at onset in schizophrenia: an international collaborative meta-analysis of individual patient data. *American Journal of Psychiatry*. 1997; 154:1220–1227. [PubMed: 9286180]
- von Zerssen D. Body constitution, psychosis and personality. *Nervenarzt*. 1966; 37:52–59. [PubMed: 5974267]
- Wahlbeck K, Forsen T, Osmond C, Barker D, Eriksson J. Association of schizophrenia with low maternal body mass index, small size at birth, and thinness during childhood. *Archives of General Psychiatry*. 2001; 58:48–52. [PubMed: 11146757]
- Ward KE, Friedman L, Wise A, Schulz SC. Meta-analysis of brain and cranial size in schizophrenia. *Schizophrenia Research*. 1996; 22:197–213. [PubMed: 9000317]
- Weinberger DR. Implications of normal brain development for the pathogenesis of schizophrenia. *Archives of General Psychiatry*. 1987; 44:660–669. [PubMed: 3606332]

Table 1

Analyses for height

Demographic group	Height in inches								Magnitude of the difference with control group [‡]				Two-way ANOVA [‡]		
	Control group		Bipolar disorder		Major depressive disorder		Schizophrenia		Bipolar disorder	Major depressive disorder	Schizophrenia				
	Mean (S.D.)	N	Mean (S.D.)	N	Mean (S.D.)	N	Mean (S.D.)	N							
													F(Dx)	df	P
White males	69.4 (2.6)	59 583	69.3 (2.7)	974	69.2 (2.7)	2808	69.3 (2.8)	878	−0.04	−0.08	−0.04	11.74	3, 64 235	***	
Black males	69.2 (2.7)	14 241	69.3 (2.7)	188	69.3 (2.9)	514	68.7 (2.8)	337	0.00	0.04	−0.19	4.16	3, 15 272	**	
White females	64.4 (2.5)	8299	64.6 (2.7)	230	64.7 (2.7)	945	65.1 (3.0)	96	0.08	0.12	0.28	4.68	3, 9562	***	
Black females	64.2 (2.5)	3817	64.3 (2.5)	65	64.8 (2.8)	401	64.4 (2.6)	78	0.04	0.23	0.08	5.81	3, 4353	***	

[‡] Effect size was calculated as the difference between each diagnostic group and control group divided by the standard deviation of the control group.

[‡] Only statistically significant results are reported in this column from among the three possible *F* tests (Group, Age and Group by Age interaction).

** *P*<0.01;

*** *P*<0.001.

Table 3

Analyses for body mass index (BMI)

Demographic group	BMI								Magnitude of the difference with control group [†]				Two-way ANOVA [‡]		
	Control group		Bipolar disorder		Major depressive disorder		Schizophrenia		Bipolar disorder	Major depressive disorder	Schizophrenia				
	Mean (S.D.)	N	Mean (S.D.)	N	Mean (S.D.)	N	Mean (S.D.)	N							
White males	23.9 (3.3)	59 583	24.0 (3.2)	974	23.8 (3.3)	2808	23.9 (3.2)	878	0.03	−0.03	0.00	(DX) 11.36	3, 64 235	****	
												(Age) 200.24	1, 64 235	****	
Black males	24.0 (3.4)	14 241	24.1 (3.3)	188	23.8 (3.4)	514	23.8 (3.3)	337	0.03	−0.06	−0.06	Older group BMI greater by 1.2 units			
												(Age) 59.41	1, 15 272	****	
White females	22.5 (2.5)	8299	22.8 (2.8)	230	22.7 (2.6)	945	22.6 (2.9)	96	0.12	0.08	0.04	Older group BMI greater by 1.3 units			
Black females	22.5 (2.8)	3817	23.0 (2.5)	65	22.4 (2.8)	401	21.8 (2.8)	78	0.18	−0.04	−0.25	Nothing statistically significant			
												(Age) 12.64	1, 4353	****	
												Older group BMI greater by 0.87 units			

[†] Effect size was calculated as the difference between each diagnostic group and control group divided by the standard deviation of the control group.

[‡] Only statistically significant results are reported in this column from among the three possible *F* tests (Group, Age and Group by Age interaction).

P<0.0001.