Education Moderates Genetic and Environmental Influences on Body Mass Index
– Findings from the Consortium on Interplay of Genes and Environment across Multiple Studies (IGEMS)

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Background

Obesity is a global health problem that has reached epidemic proportions, and prevalence rates continue to increase, across all age groups. Given that obesity is associated with increased risk of various diseases, including common late life diseases such as diabetes and dementia, studies exploring the origins of obesity seem more relevant than ever.

Why this study is important:

- Twin studies have shown that genetic influences largely contribute to individual differences in body mass index (BMI), but lower educational level is also associated with higher BMI. A clear understanding of the role of genetic influences on this association has not been achieved.
- Most people gain weight across midlife, while in late life the increases begin to plateau, and subsequently declines are observed during the last decades of life. Studies focusing on transitional stages of life are needed to unpack the origin of individual differences in BMI.
- Sex differences in both educational level and BMI must be considered while attempting to unpack these complex associations.

The Consortium on Interplay of Genes and Environment across Multiple Studies (IGEMS), including eight twin studies, is uniquely well-positioned to study the genetic and environmental influences on BMI across the adult life span, including sufficient numbers of twins to study both age and sex differences.

Sample

Eight studies are involved in the IGEMS consortium.

<u>Swedish samples</u>
- The Swedish Adoption/Twin Study of Aging (SATSA)
- Origins of Variance in the Old-Old (OCTO-Twin)
- Ageing in Women and Men: A Longitudinal Study of Gender Differences in Health Behaviour and Health among Elderly (Gender)
- Twin and Offspring Study in Sweden (TOSS)

<u>Danish samples</u>
- The Longitudinal Study of Aging Danish Twins (LSADT) in Denmark
- Middle-Age Danish Twin (MADT)

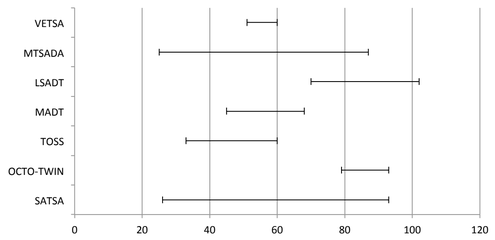
<u>U.S. samples</u>
- The Minnesota Twin Study of Adult Development and Aging (MTSADA)
- The Vietnam Era Twin Study of Aging (VETSA)

Collectively, these studies include over 17,500 participants (including nearly 2,600 monozygotic [MZ] and 4,300 dizygotic [DZ] twin pairs and over 1700 family members) whose ages ranged from 24 to over 95 at their intake assessments. For the current analyses, which excluded the opposite-sex twins (all twins in Gender and some in MTSADA), 12,425 persons had information about BMI and education.

Measures

BMI was calculated as weight in kilos divided by squared height in meters (kg/m^2). Educational level (harmonized as years of education) was self-reported. Both BMI and education were standardized within country, birth year, age group, and sex.

Figure 1. Age ranges in the seven included studies



Statistical Methods

Quantitative genetic modeling was used to examine how genetic, shared and nonshared environmental variances for BMI differed with educational level, and the extent to which genetic, shared and nonshared environmental factors contributed to the correlation between BMI and educational attainment, analyzing middle-aged, young-old and old-old men and women separately.

Figure 2. Model of Moderated Genetic and Environmental Influences

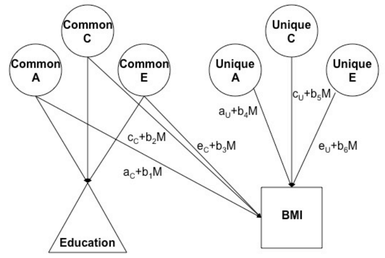
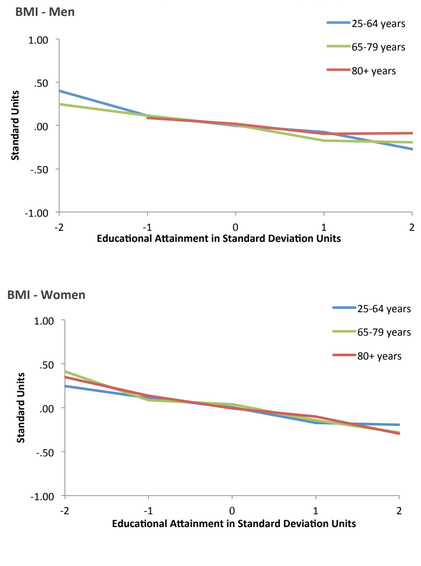


Table 1. Sample characteristics

	N (men/women)	Mean (SD)		
		All	Men	Women
BMI				
Middle age (25-64)	6282 (3716/2566)	25.8 (4.3)	26.8 (4.1)	24.3 (4.2)
Young-old (65-79)	4369 (1880/2489)	24.8 (3.9)	25.4 (3.4)	24.4 (4.2)
Old-old (80+)	1774 (600/1174)	24.1 (3.9)	24.8 (3.5)	23.7 (4.1)
Education				
Middle age (25-64)	6282	11.9 (3.2)	12.4 (3.1)	11.2 (3.2)
Young-Old (65-79)	4369	8.9 (3.0)	9.5 (3.3)	8.5 (2.7)
Old-old (80+)	1774	7.7 (2.5)	8.2 (2.8)	7.4 (2.3)

Figure 3. Standardized BMI by educational level and age group



Results – Figure 3

In general, mean BMI was higher among those with lower education. This was true across age groups and sex with exception of the oldest men.

Results – Figure 4

Among both men and women and across all age groups, the <u>total variance</u> in BMI decreased with higher educational level, except among the old-old women. There was greater variation in BMI among those with lower educational levels.

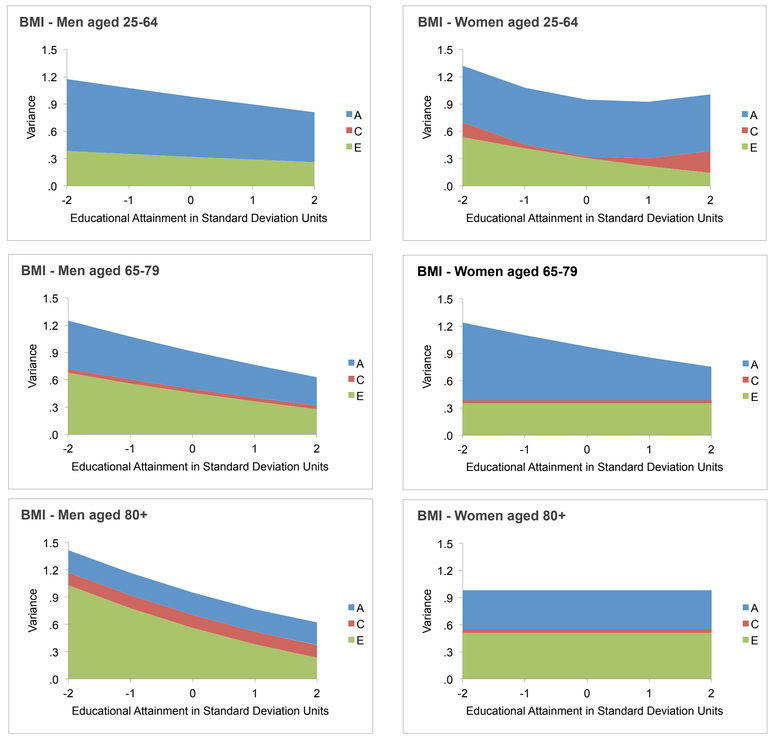
The changes in the genetic and environmental variances across educational level indicated gene and environment interplay between BMI and educational level. This interplay was evident for all except the old-old women.

Among men, the decrease in variance with higher educational level was largely due to a decrease in individual-specific environmental (E) influences. This was most pronounced among the oldest men.

Among women, results were less consistent across age groups. The decrease in variance in the youngest group involved environmental influences, whereas the decrease in the young-old group involved genetic variance.

As a proportion of the total, genetic (A) variance for BMI declined with age as demonstrated by the shrinking blue bands across age groups. The variance in BMI was thus to a greater extent attributable to environmental factors than genetic factors.

Figure 4. Variance in BMI by levels of education



Conclusions

Variation in BMI was consistently higher across age groups and sex among those with lower educational level than among those with higher educational level. In general, persons with lower educational level had higher BMI than those with higher education, as expected.

Overall, the genetic influence on BMI decreased with increasing age and the influence of environmental factors increased. The stronger influence of the nonshared environment with older age was especially pronounced among men with lower educational level.

There is evidence of gene and environment interplay between BMI and educational level.

This study suggests new ways of understanding the education-obesity gradient.

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