BMI and Health

Evidence from the Union Army Records*.

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ABSTRACT

This paper investigates the impact of BMI on the occurrence of diseases and mortality among the Union Army Veterans, with a first examination between 1891 and 1905. The findings suggest that BMI has a significant effect on both morbidity and mortality. In general, we found that higher BMI is protective, as indicated by less number of diseases and less severity of diseases.

The impact of BMI on morbidity is disease specific. Lower BMIs are associated with higher risk of developing respiratory and gastrointestinal diseases, and higher BMI is related with higher risk of rheumatism and musculoskeletal diseases. Lowest and highest BMI are both associated with higher risk of having cardiovascular conditions.

As for the impact of BMI on mortality, the optimal BMI was identified within the second BMI quintile between 20.7 and 22.0. The first and fifth quintiles are significantly associated with higher mortality risk.

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BMI AND HEALTH
EVIDENCE FROM THE UNION ARMY RECORDS

I. Introduction

Anthropometric measures such as height and weight adjusted for height, or Body Mass Index (BMI), have proven to be useful for the study of health in modern and past populations. The use of these measures relies on the idea that height and weight reflect prior nutritional experience to the extent that they provide a record of how much individuals have eaten and what are their demands of food energy. As Riley pointed out, whereas height is most reliable, as an indicator of previous nutritional status, the BMI is more valuable in conveying the recent nutritional status, after the individual growth has been completed (Riley, 1994)

Since these indicators tell us much about the general ability of an organism to cope with its external environment, and since such ability will be instrumental in forestalling the onset of many diseases, it stands to reason that the nutritional status can serve as a guide in assessing not just general health but also prevalence of specific conditions.

The 20th century witnessed an increase in human body weight. As Su highlights for white American males, average adulthood BMI has increased from 22.6 in late 19th century to 28.0 at the end of 20th century. Such an ongoing trend has drawn a lot of attention to the role of BMI in mortality and morbidity (Su, 2003)

Several studies have focused on the relationship of BMI and mortality[1], but very few have explored the relationship between BMI and diseases and, among those, only a tiny fraction has looked at the problem from a historical point of view.

The purpose of this paper is then to determine through the BMI, the impact of the nutritional status on the health and mortality among a very data-rich sample of 19th century individuals. More specifically we want to address the following questions: were individuals with lower BMI more likely to develop certain conditions?, which?, what is the impact of the BMI on their health? did BMI have any effects over the length of their life-span?

One of the pioneering works in this respect is Costa's paper (Costa, 1996) relating health status, BMI and labor force participation among older man. She measured, for the Union Army veterans, the BMI and the relative risk of certain chronic conditions to investigate the relationship between health and retirement among older men. Just as in her study, in ours we rely on the information of Union Army veterans (Fogel, 2000), but with some significant differences: although her study pertains to the relationship between BMI and health, its main focus is on the labor force participation for older veterans. She also developed this study when the process of collecting the sample was not yet completed and concentrated on a small part of the sample. There are also some recent studies that link BMI and diseases for current times, mostly cardiovascular

[1] The Waaller study about the Norwegian population (Waaler,1984) Riley's article about height nutrition and mortality (Riley, 1994) and Costa's developments on height and weight and its impact on mortality based on the Union Army veterans records (Costa, 1993) along with the work of Fogel and others in the development of the Early Indicators Project (Fogel et al. 1991) are only few examples of them.

conditions, arthritis, diabetes, hypertension and certain types of cancer[2] Usually these studies try to find the impact of weight on functional limitation and life expectancy (Hime, 2000).

The paper proceeds as follows. In the second part we present an overview of the data employed, the third section uses regression analysis to determine the impact of BMI on the occurrence of the disease, the fourth part consists of an analysis to reveal the effect of the BMI at first examination on the subsequent survival, and the last section concludes.

II. Description of the Data

We use the information collected for the Union Army veterans through the pension program that benefited people who took part in the U.S Civil War. The Union Army data contains records between 1861 and 1940, of 35,570 white men who belonged to 331 companies. It contains socioeconomic as well as medical information. The medical information is recorded in the Surgeon's Certificates data for about 50% of the veterans who claim different kinds of disability. The medical examination was performed by a group of physicians that measured the disability of the individuals in terms of ability to do manual work.

[2] For example, the Bhargava study which relates height and weight with the risk of diabetes and coronary heart disease. (Bhargava, 2003)

Congress originally established the basic system of pension laws called General Law that limited the benefit to those who proved their disabilities were as a result of the war. Later, in 1890 the Disability Act was approved marking the beginning of a more universal disability and old pension program that only required pensioners to have served in the military for 90 days. The presence of the war-related condition clause generates a bias in the sample before 1890 as for the diseases that the veteran could claim. On the other hand, the old age law, introduced in 1907, gave the veterans the opportunity to apply for old age pension with higher amounts of pension than those of the disability pension, something that could represent another type of bias in the sample. To avoid that, we restricted our study to a smaller sub-sample that covers people's claim for disability pension between 1891 and 1905, these 15 years represent the largest number of applications. We basically do the analysis over 5,945 men that had their first exam between 1891 and 1905.

To determine whether the veteran had or not the disease we used variables that indicate the veteran was diagnosed with the disease as well as the rating and related variables when the disease was not mentioned in the former ones.[3] We also restricted the scope of our analysis to the more frequent diseases. Table 1 shows the number of veterans who had each of the main 20 conditions. From the most frequent diseases among Union Army veterans, we chose five conditions to perform the analysis: rheumatism/msk, cardiovascular, respiratory diseases, gastrointestinal and rectum/hemorrhoids. These five diseases are the most common ones in our sample, once

[3] For a complete explanation see the work developed by Canavese and Linares (Canavese and Linares, 2004)

we exclude general appearance and injury. These last two conditions were excluded for specific reasons. Doctors were required by the Pension Bureau to assess the general appearance of every veteran: as such it bundles together many different conditions that often have no medical connection with one another and that cannot be retrieved from the data. As for injury, we consider that to be the result of an exogenous event, unrelated to the dynamics of health induced by BMI.

In each medical examination the doctors were instructed to give the weight of the veteran at each exam. This information and the height at enlistment when no growth was expected, allowed us to calculate an accurate BMI for the Union Army Veterans with 45 years or more. Graph 1 shows the BMI for the veterans who were examined for the first time. The average for the reduced sample is 23.32 and it generally decreases as the veterans age.

Table 2 presents some of the most important characteristics of the diseases such as the average age of onset, rating and number of diseases for veterans examined for the first time between 1890 and 1905. We notice a slight variation in the age of onset of the disease: the latest is cardiovascular at (54.2) years and the earliest is gastrointestinal (53.1). The ratings show by far more severity in the case of cardiac conditions (0.194) and gastrointestinal diseases (0.187). Rheumatism/msk presents the smallest rate (0.164). The number of diseases diagnosed with gastrointestinal (5.7) and rectum/hemorrhoids (5.1) is higher than the other three conditions, rheumatism/msk presents on average the lowest number of diseases (4.25). As a result rheumatism is the most prevalent disease in this period but it was less incapacitating than the rest of the diseases considered, in contrast gastrointestinal presented higher comorbidity and a higher rate of disability.

We also checked the prevalence rates of these diseases by age group in graph 2. We found that by far the most prevalent disease is rheumatism/msk with levels over 60 %. As the veteran gets older, there is an increasing trend of cardiovascular and gastrointestinal and a decreasing but shallower path of respiratory and rectum/hemorrhoids.

III. BMI and Diseases

To get a rough idea of the BMI's impact on the number and severity of the diseases we divided the BMI into quintiles from lowest to highest and compared prevalence of diseases across those quintiles. Table 3 shows that across the sample (including all diseases), the higher the BMI, the lower the number of diseases. With respect to the sum of the ratings as a proxy of overall health we observe a curvilinear effect but clearly affecting more the lowest quintile.

Looking at specific conditions we found that gastrointestinal and respiratory conditions showed less prevalence, as the BMI is higher although a slight curvilinear effect is identified. Weaker veterans present more the disease. For the cardiovascular conditions the curvilinear effect is stronger, showing that veterans with the lowest and the highest BMI are more affected by the disease. Rheumatic and musculoskeletal diseases show the opposite trend affecting more veterans with higher BMI, at the end we also notice a slight curvilinear effect. For the rectum/hemorrhoids it seems that the BMI has not a clear pattern on affecting the occurrence of the disease.

To measure the overall effect of the BMI we perform a multivariate analysis that tries to determine the effect of the BMI on the occurrence of the diseases controlled by the age the veteran had at the first exam and by other explanatory variables. We used categorical variables for occupation in which we define if the veteran worked at enlistment as a farmer, professional, artisan, manual worker or had another activity and for state of residence at enlistment, where we identified by zones if the veteran was living in the North East part of the country, North central, Central or in another area[4]. We use another dummy if they were ever married and a variable to determine the number of battles he fought.

We first want to explore if stronger veterans (higher BMI) are more resistant to diseases. We run an OLS regression in which we evaluate the impact of the BMI on the severity of the diseases measured as the sum of the disability ratings[5] of all the conditions the veteran presented the first time he was examined (Table 4[6]). We found an inverse and significant effect of the BMI on health veterans with lower BMI were more

[4] N-east include veterans who lived in New York, Pennsylvania, Massachusetts, Virginia, Connecticut, New Jersey and Maryland; North Central includes the states of Indiana, Illinois, Ohio and Michigan; Central includes Iowa, Montana, Kansas, Kentucky and Nebraska

[5] The sum of disability ratings within this sample is the most approximate indicator of the overall health of the Union Army veterans. As Canavese and Linares pointed out this is the measure that better reflects the total disability rate given in some cases by doctors. (Canavese and Linares,2002).

[6] All the tables in the appendix have the standard error between brackets.

likely to have health problems. There is a moderate and slightly significant effect of the square BMI showing that the linear effect is not so important. The age was also an important factor in determining the health and we found a slight effect of the state of residence for those who lived in the central area compare with veterans in the n-east region. The rest of the variables are not significant. As graph 3 highlights veteran's ratings are higher as the BMI is lower then weaker veterans are prone to present worst health conditions.

We also want to test the impact of BMI on the number of diseases or comorbidity the veteran presented. Table 5 shows the results of regression. In this case we found basically the same kind of results as for BMI, a very significant and negative impact of the BMI on number of diseases. The relation is linear. Age is not an important factor for the number of disease. To live close to the Michigan Lake region (North central) have a more important effect on number of diseases than those who lived in the North east region. In this case occupation have some significant results. Being an artisan or to do manual labor implies less number of diseases than farmers. Ever being married had a positive effect showing that the higher the probability of being married the higher the number of diseases, this maybe counter intuitive in the light of some recent medical research. Graph 4 shows the probability of having higher comorbidities is associated with lower BMIs. The relation is almost linear.

We also want to know the impact of BMI on the risk of having the diseases. For that purpose we run a logistic regression where the dependent variable is a dummy representing the occurrence of the disease. Table 6 shows the results. For all analyzed diseases except for rectum/hemorrhoids the BMI has a significant effect. For cardiovascular, respiratory and gastrointestinal diseases the effect is negative, i.e. the less BMI the more likely to present the disease, there is also a significant effect of the BMI square. Rheumatism shows a different behavior: the higher the BMI the more likely to have the disease, something that is consistent with the idea that the musculoskeletal conditions mostly affect obese people. For the four diseases a non-linear relationship is shown. This curvilinear effect is more pronounced in the case of cardio and gastrointestinal. The calculation of the probability of having the disease is shown in the graph 5. According to these results the probability of having cardiovascular, gastrointestinal and respiratory conditions present an optimal measure of BMI of 25. It certainly affects mostly people with lower BMI although the veterans with higher BMI are at a higher risk. The probability of getting rheumatism increases as the BMI is higher and for the probability of getting rectum/hemorrhoids the BMI is not an important factor.

Age at first exam has an impact on rheumatism and respiratory disease although less significant showing also a no linear effect in both cases.

We also observe in table 6 the results of the regression explaining the odds of contracting the diseases by state of residence and occupation. The odd ratio here compares with the omitted category: if the veterans lived in the Northeast region for the state of residence or if they were farmers in the case of occupation. The results show a substantial higher probability of having rectum/hemorrhoids and less of having cardiovascular condition for those whom lived in places different than the states defined for the Northeast region. There is also a higher risk of rheumatism for those who lived in the central part compare to veterans in Northeast region. As for the occupation veterans who worked like artisans and manual labor were less likely to have gastrointestinal that those who were farmers, and those whose occupation imply manual labor were less prone to have cardiovascular conditions than the farmers.

If the veterans were ever been married does not have an impact for diseases like cardiovascular, rheumatism/msk and respiratory diseases, but for the other two diseases it presents a positive relationship then to be married increased the probability of having gastrointestinal and rectum. The number of battles the veteran fought is not significant for any of the diseases.

IV. The Impact of BMI on Survival of the Union Army Veterans

We then consider the effect of BMI at first examination on subsequent survival. Since more veterans had their first physical examinations in 1891 than in any other single year, we selected all those who were firstly examined in 1891 as our survival sample, with a sample size of 3,416 veterans. To see if there is any difference between long-term and short-term effect of BMI, we evaluate the effect of BMI on survival in two periods: 1891 to 1905, and 1891 to 1946, using two Cox Proportional Hazard models.

The results from the two Cox regressions (Table 7) suggest that, after controlling for the effects of age at examination, occupation at enlistment, residence area, and several other variables, there is an asymmetrical ‘v’ shaped relationship between BMI and relative mortality risk as is shown in graph 6. This relationship is more salient in the short-term (1891-1905) model than that in the long-term (1891-1946) model. In both models, the optimal BMI lies in the second quintile, with the lowest and highest BMI quintiles associated with a higher mortality risk. These effects are all significant at a level of 5% in both models. Since deviation contrast was applied in both Cox regressions, each coefficient of the BMI quintile reflects how much its effect on mortality risk deviates from the overall average effect of BMI. For example, in the short-term model the coefficient for the second BMI quintile is (-0.173), which means that controlling for the effect of the other variables in the model, the relative odds of dying for veterans in the second BMI quintile, compared with the overall odds of dying, is 84.1 percent as much. Thus, mortality risk for being in the second BMI quintile implies a 16 percent mortality advantage over the average mortality level.

We also observed a remarkable effect of occupation at enlistment on survival after first examination in 1891 among the Union Army veterans. Being farmer is associated with a substantial survival advantage in both models. For example, in the short-term model, for those veterans who were farmers at enlistment, their relative odds of dying is 81.7 percent of the overall odds of dying, almost 20 percent lower than the overall average mortality. As for the other occupations the mortality risk for those in the manual labor is higher than the overall mortality, which is especially the case in the short-term survival model. We also found that being artisan is associated with 9.3 percent higher mortality risk in the long-term survival model.

Veterans from the Northeast region had higher mortality risk than those from the other regions. For example, in the long-term survival model, being from the Northeast is associated with 9.4 percent higher mortality risk than the overall average level, after controlling for all the other variables in the model. Since this is the region where the earliest urbanization and industrialization developed in the United States, this tends to suggest that urban settings in the middle 19th century, in general, were detrimental to health, which is consistent with previous findings. (Haines, 2001; Wilson and Pope, 2003).

Contrary to our expectations, we found number of battles participated by the veterans is inversely related to mortality risk, which is especially the case in the short-term survival model. After controlling for the effects from the other variables in the model, for each additional battle in which the veteran took part, the relative mortality risk becomes 8.3 percent less. How to account for this? A plausible explanation would be that only those relatively healthy and uninjured veterans were selected to participate in another battle, and when they survived to 1891, they were on average in a better physical condition than the rest of the veterans.

Veterans who were diagnosed with cardiovascular diseases and veterans who had more number of diseases at first examination in 1891, on average, had higher mortality risk than the others. However, these effects are not significant in both of the survival models.

V. Conclusions

This paper explored the impact of BMI on five diseases and the survival time condition for veterans of the Union Army sample. We found that the BMI has a clear impact on the overall health of this population (measured by the severity of the diseases). Lower BMI implies higher severity of the diseases. The same effect occurs when we evaluate the number of comorbidities: larger number of diseases as the BMI decreases then higher BMI is apparently more protective against diseases than lower BMI.

Our results indicate that the BMI has a significant effect in the occurrence of four of the five studied conditions, all diseases but rectum/hemorrhoids showed them. Those tendencies, while statistically significant, do not always point in the same direction, then the impact of BMI is disease specific. For gastrointestinal and respiratory diseases, higher BMI is in general associated with a lower risk of being diagnosed with these diseases. On the contrary, for rheumatism and MSK, higher BMI significantly increased the disease risk. As for cardiovascular diseases, the impact of BMI is curvilinear in nature, with extreme low and high BMI associated with higher risk.

This implies that if we only rely on information of BMI to predict changes in the prevalence of diseases in the future, and if all the other conditions are held constant, increased BMI implies more prevalence of rheumatism and MSK diseases and less prevalence of respiratory diseases and gastrointestinal diseases. As for cardiovascular diseases, it becomes hard to tell because of its curvilinear relationship with BMI. Thus, the evidence seems to suggest that increased BMI might be a double-edged sword in the sense that while it decreased the prevalence of certain diseases, it also increased the risk of other certain diseases. To take all these findings into account, we tend to argue that increased BMI at the population level is associated with a better disease environment.

We also observed a remarkable impact of BMI on subsequent survival. Among the Union Army veterans, the optimal BMI in terms of survival after middle age is in the second BMI quintile, which ranges from 20.7 to 22.0. Again, constant the other conditions, a dramatic increase in BMI would imply higher mortality, because although it can reduce the proportion of the underweight people with higher mortality, it will also increase the proportion of people within the 4^{th} and 5^{th} quintile in the Union Army sample.

However, despite the dramatic increase in adulthood BMI over the century, mortality has declined substantially in the past two centuries. There are several reasons for this, one is that BMI just tells part of the story of mortality decline, advancements in technology and medical interventions, as well as public health programs and health education, have contributed to mortality decline. Then, although we are living with an unprecedented "obesity epidemic", we can still enjoy the lowest mortality level ever. On the other hand there are evidence that suggests a shift upward on the optimal BMI in terms of mortality (Su, 2003). Therefore, to predict future mortality based on the BMI-mortality relationship derived from past population could be overestimated.

There is a paradox in our findings concerning the occupational difference in morbidity and mortality. To be a farmer at enlistment is associated with higher risks of developing most of the diseases considered in this paper, however, there is clear evidence suggesting that veterans who were farmers at enlistment had a substantial survival advantages over veterans from the other occupations. How to reconcile these two findings? According to Chulhee Lee's the immune system for farmers was in general not so adaptive to the disease of the urban area where higher prevalence of infectious has selected out those people with stronger immune system to survive to the time they could join in the Union Army (Lee,2003). At the same time, being a farmer in the 19th century also has some advantages such as more access to fresh air, more stable food supply, exercises from farming etc. which could eventually leads to survival advantage.

VI. Bibliography

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VII. Appendix

Table 1

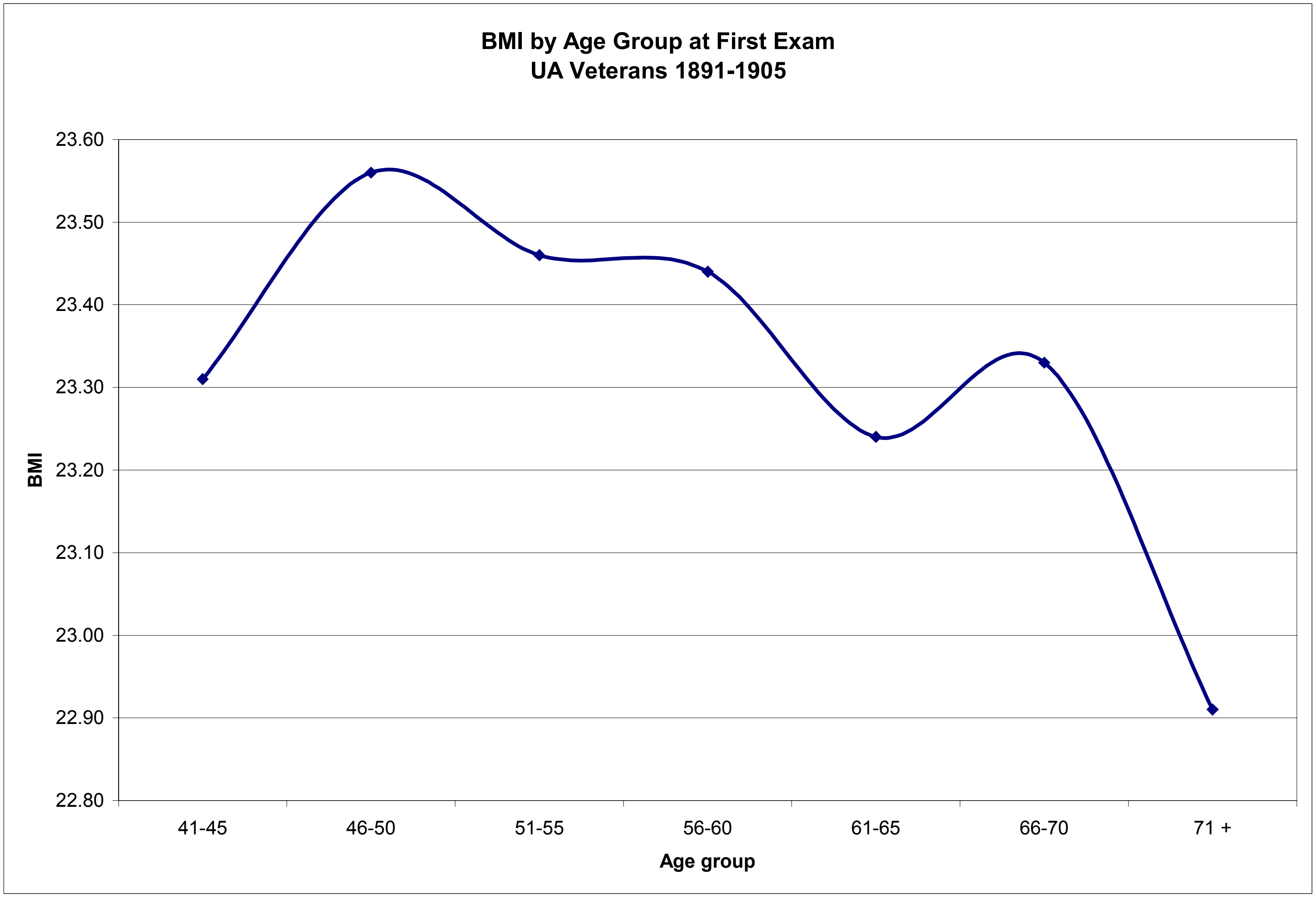
Number of Veterans per Disease UA 1891-1905	
Disease	**No. Veterans**
Rheumatism/MSK	3,433
Gral Appearance	3,230
Cardiovascular	1,886
Respiratory	1,737
Injury/GSW	1,414
Rectum/hemorrhoids	1,363
Gastrointestinal	1,312
Eyes	1,249
Genito-urinary	1,150
Nervous	925
Liver	809
Ear	803
Diarrhea	679
Hernias	651
Spleen	312
Varicose Veins	282
Infectious and Fevers	133
Neoplasm/Tumor	103
Endocrine	42
Gallbladder	8
Conditions/Veterans	4.12

Table 2

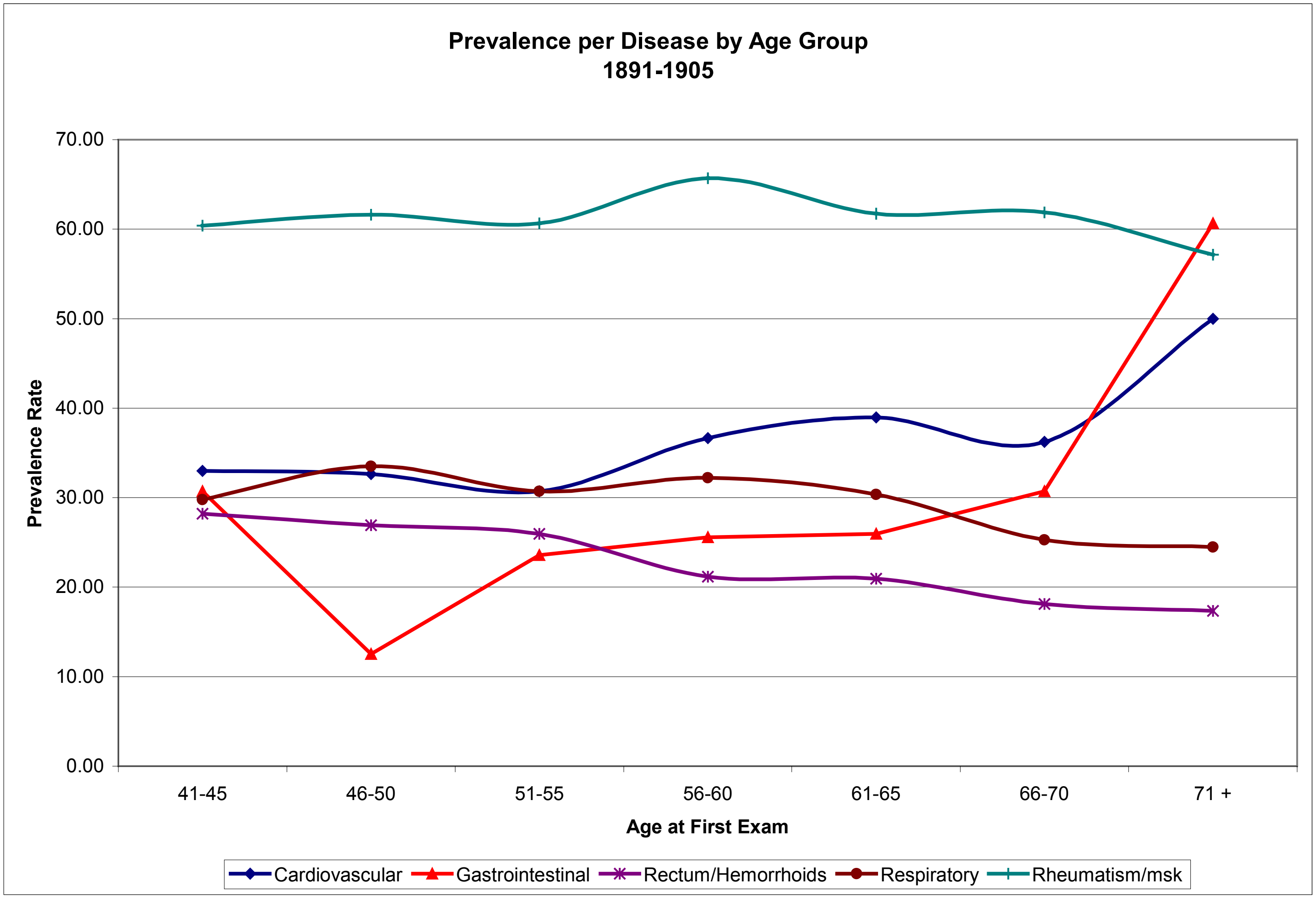
Main Statistics of Diseases at First Exam 1891-1905						
Diseases	**Age at first Exam**		**Rates***		**Number of Diseases**	
	Num Obs.	Mean Age	Num Obs.	Mean rate	Num Obs.	Mean No
Rheumatism/MSK	3,433	53.7	2,936	0.164	3,433	4.25
Cardiovascular	1,886	54.2	1,657	0.194	1,886	4.91
Respiratory	1,737	53.3	1,506	0.179	1,737	4.81
Gastrointestinal	1,312	53.1	1,165	0.187	1,312	5.77
Rectum/Hemorrhoids	1,363	52.7	1,227	0.182	1,363	5.15

(*) Sum of rates per all conditions the veteran was rated at first exam.

Graph 1


BMI by Age Group at First Exam
UA Veterans 1891-1905
23.60
23.50
23.40
23.30
23.20
23.10
23.00
22.90
22.80
BMI
41-45
46-50
51-55
56-60
61-65
66-70
71 +
Age group

Graph 2



Prevalence per Disease by Age Group
1891-1905
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Prevalence Rate
41-45
46-50
51-55
56-60
61-65
66-70
71 +
Age at First Exam
Cardiovascular
Gastrointestinal
Rectum/Hemorrhoids
Respiratory
Rheumatism/msk

Table 3

BMI Quintiles and Morbidity at First Exam 1891-1905					
	BMI Quintiles from the Lowest to the Highest				
	1st	2nd	3rd	4th	5th
Overall diseases					
Number of Diseases	4.173	3.837	3.880	3.700	3.653
Sum of ratings	0.172	0.154	0.156	0.149	0.155
Specific Diseases(%)					
Cardiovascular	37.19	32.38	33.23	31.56	33.62
Gastrointestinal	29.65	24.20	21.87	22.64	21.53
Respiratory Dis.	38.89	30.15	31.32	30.50	29.37
Rheumatism/MSK	56.75	59.77	66.67	63.55	64.79
Rectum/Hemorrhoids	26.25	23.04	26.43	25.93	21.85
Observations	941	942	942	941	943

Note: BMI quintiles were constructed only for those between 45 and 65 years old

Table 4

OLS Using Severity of the Disease at First Exam as Dependent Variable 1891-1905	
Variables	**Coefficients**
Constant	0.507***
	(0.92)
BMI at 1st Exam	-0.0028***
	-0.001
BMI^2 /10	-0.0002*
	(0.000)
Age 1st Exam	-0.0133***
	(0.003)
$(\text{Age 1st Exam})^2/10$	0.0014***
	(0.000)
State of residence (reference = N-East)	
Central	0.0125**
	(0.005)
North Central	0.00071
	(0.005)
Other	-0.0085*
	(0.005)
Ocupation (reference = Farmer)	
Artisan	0.0036
	(0.005)
Manual Labor	0.00481
	(0.005)
Professional	0.00836
	(0.006)
Other	0.004
	(0.008)
Ever Married	-0.0054
	(0.004)
No. of battles	0.001
	(0.001)
Observations	4,167

***Significant at 1%

** Significant at 5%

*Significant at 10%

Graph 3

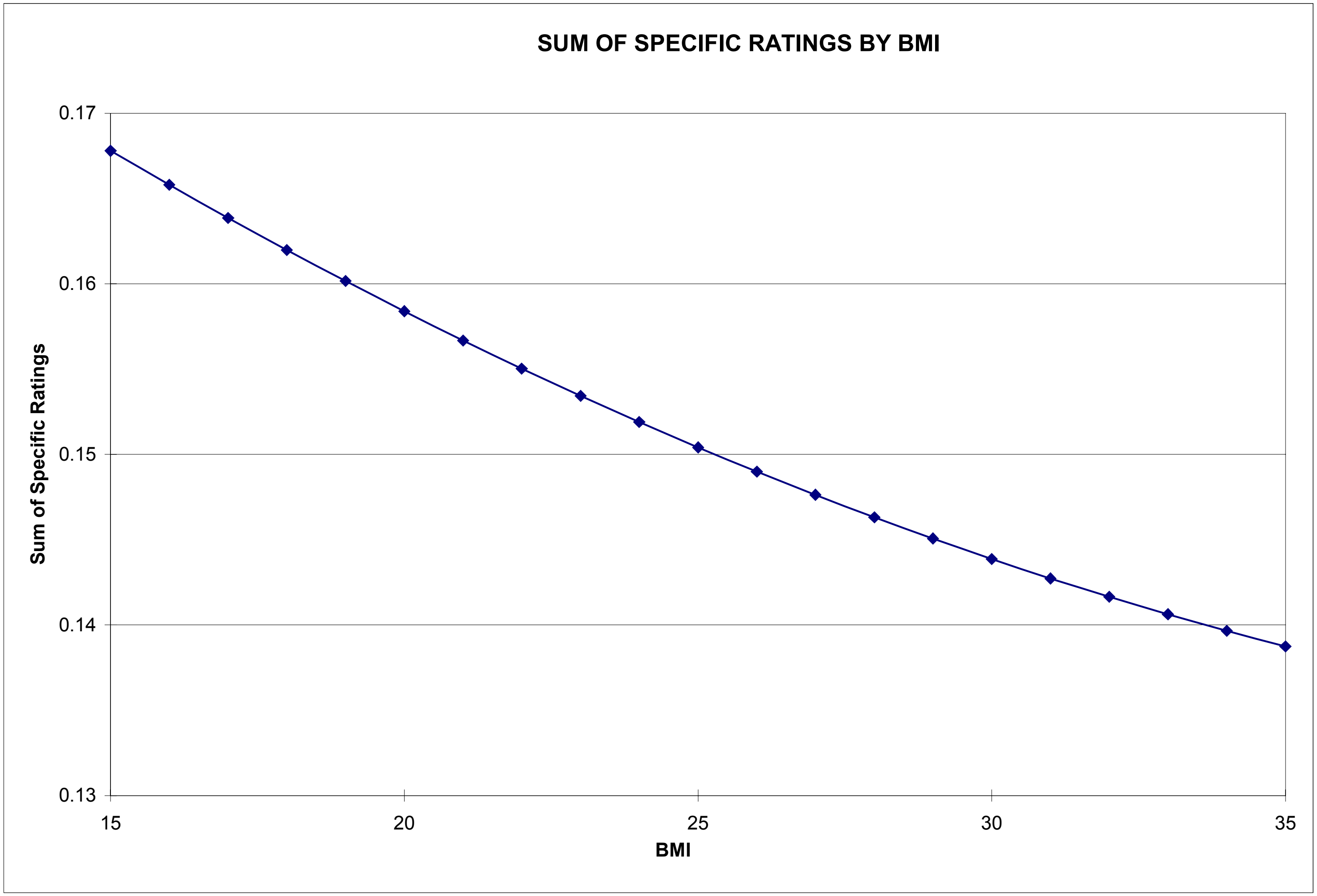

SUM OF SPECIFIC RATINGS BY BMI
Sum of Specific Ratings
0.17
0.16
0.15
0.14
0.13
15
20
25
30
35
BMI

Table 5

OLS Using Number of Disease at First Exam as Dependent Variable 1891-1905	
Variables	**Coefficients**
Constant	3.566 **
	(1.553)
BMI at 1st Exam	-0.0037 **
	(0.015)
BMI^2 /10	-0.00201
	(0.003)
Age 1st Exam	0.0199
	(0.055)
$(\text{Age 1st Exam})^2/10$	0.00039
	(0.005)
State of residence (reference = N-East)	
Central	0.05355
	(0.090)
North Central	0.263 ***
	(0.077)
Other	-0.0182 **
	(0.077)
Occupation (reference = Farmer)	
Artisan	-0.201***
	(0.078)
Manual Labor	-0.188**
	(0.085)
Professional	0.116
	(0.11)
Other	0.00531
	(0.128)
Ever Married	0.172***
	(0.066)
No. of battles	0.01585
	(0.022)
Observations	4,961

***Significant at 1%

** Significant at 5%

*Significant at 10%

Graph 4

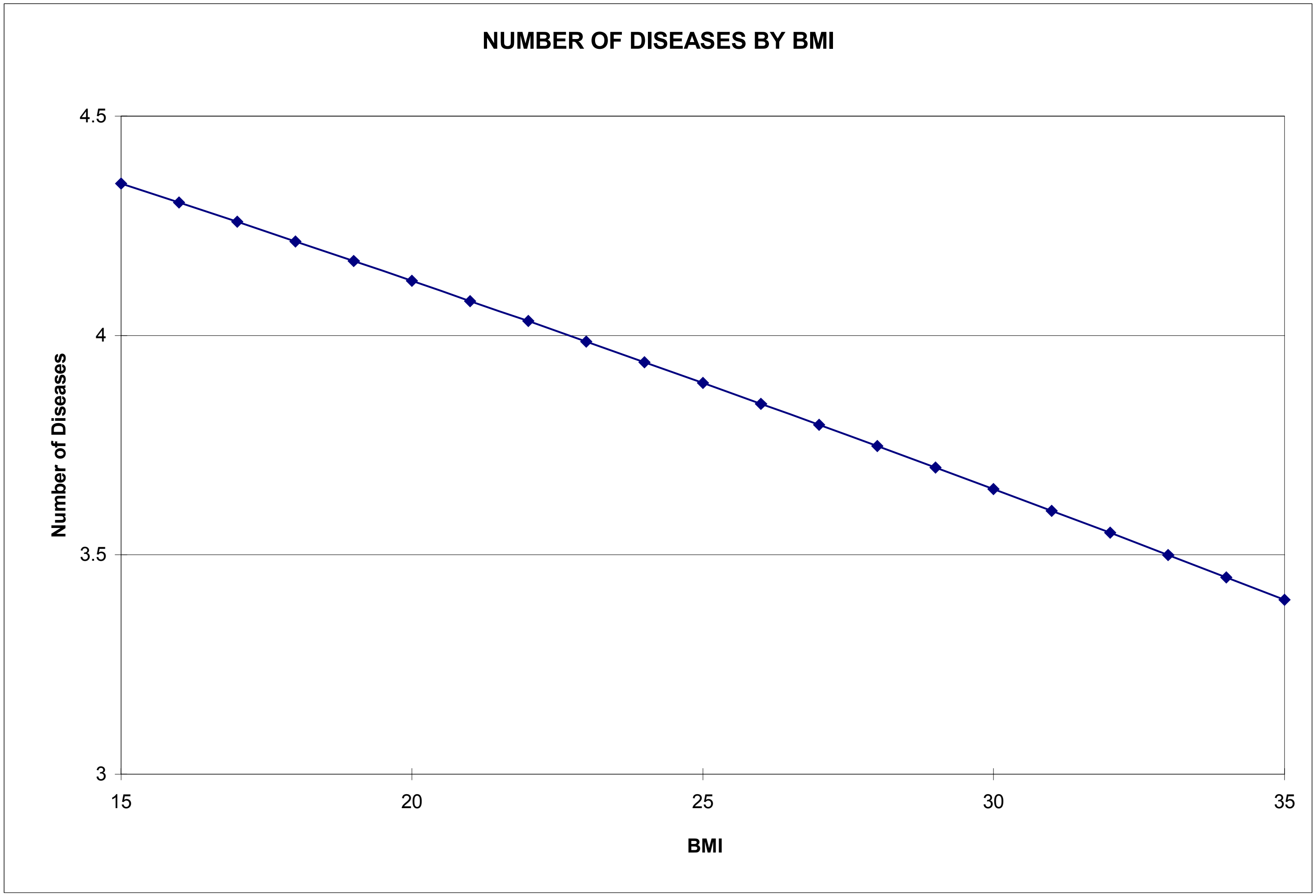

NUMBER OF DISEASES BY BMI
4.5
4
3.5
3
Number of Diseases
15
20
25
30
35
BMI

Table 6

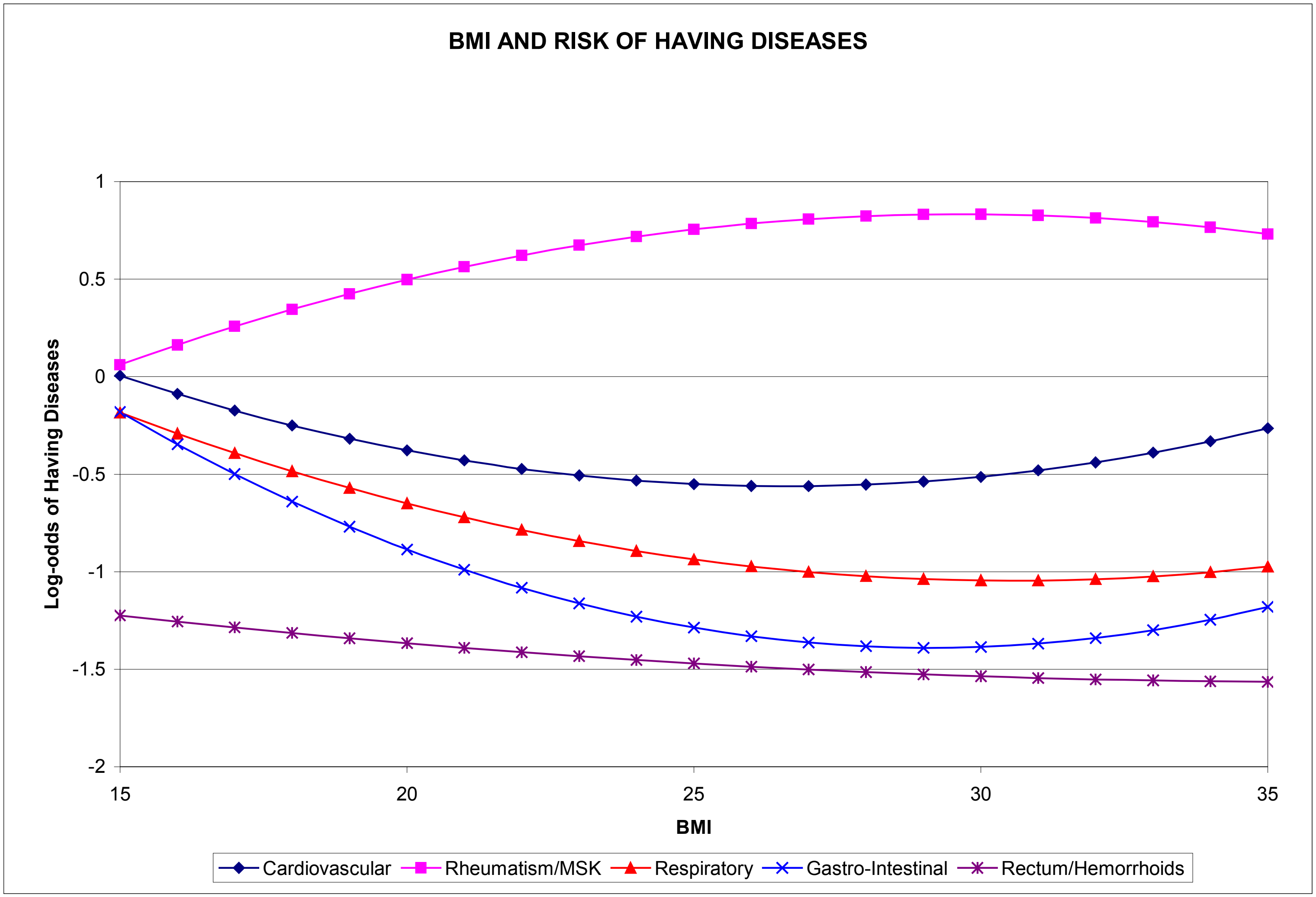
Logistic Using If the Veteran Had the Disease at First Exam as Dependent Variable 1891-1905					
Variables	**Diseases Diagnosed at First Exam**				
	Cardiovascular	Rheumatism/MSK	Respiratory	Gastrointestinal	Rectum/Hem.
Constant	2.073	-5.775***	-0.4041	4.524**	-0.1339
	(1.854)	(1.823)	(1.966)	(2.082)	(2.145)
BMI at 1st Exam	-0.224 ***	0.213***	-0.218***	-0.352***	-0.055
	(0.074)	(0.074)	(0.07)	(0.081)	(0.085)
BMI^2 /10	0.042 ***	-0.035**	0.035**	0.06***	0.007
	(0.014)	(0.014)	(0.015)	(0.015)	(0.0016)
Age 1st Exam	-0.005	0.117**	0.105*	-0.020	-0.000
	(0.057)	(0.056)	(0.062)	(0.065)	(0.067)
$(\text{Age 1st Exam})^2$/10	0.002	-0.009**	-0.0008*	0.001	-0.019
	(0.005)	(0.0049)	(0.005)	(0.005)	(0.006)
State of residence (reference = N-East)					
Central	-0.194 **	-0.220**	0.106	0.182*	0.564***
	(0.0937)	(0.091)	(0.096)	(0.104)	(0.1038)
North Central	-0.177 **	-0.018	0.2215	0.208**	0.496***
	(0.080)	(0.080)	(0.082)	(0.09)	(0.091)
Other	-0.324***	-0.294***	0.1233***	-0.002	0.244**
	(0.081)	(0.079)	(0.083)	(0.094)	(0.095)
Occupation (reference = Farmer)					
Artisan	-0.062	-0.040	-0.040	-0.341***	-0.075
	(0.081)	(0.079)	(0.083)	(0.093)	(0.091)
Manual Labor	-0.232 **	0.03	-0.092	-0.511***	-0.205**
	(0.091)	(0.087)	(0.092)	(0.107)	(0.104)
Professional	-0.045	-0.112	0.069	-0.183	0.068
	(0.113)	(0.111)	(0.115)	(0.127)	(0.125)
Other	-0.094	0.166	-0.008	-0.300*	0.0042
	(0.136)	(0.135)	(0.137)	(0.155)	(0.149)
Ever Married	0.079	0.07	0.021	0.167**	0.219***
	(0.070)	(0.068)	(0.071)	(0.080)	(0.080)
No. of battles	-0.027	-0.013	-0.0016	-0.040	-0.035
	(0.024)	(0.023)	(0.024)	(0.028)	(0.028)
Observations	5,131	5,131	5,131	5,131	5,131

***Significant at 1%

** Significant at 5%

*Significant at 10%

Graph 5



BMI AND RISK OF HAVING DISEASES
Log-odds of Having Diseases
1
0.5
0
-0.5
-1
-1.5
-2
15
20
25
30
35
BMI
Cardiovascular
Rheumatism/MSK
Respiratory
Gastro-Intestinal
Rectum/Hemorrhoids

Graph 6

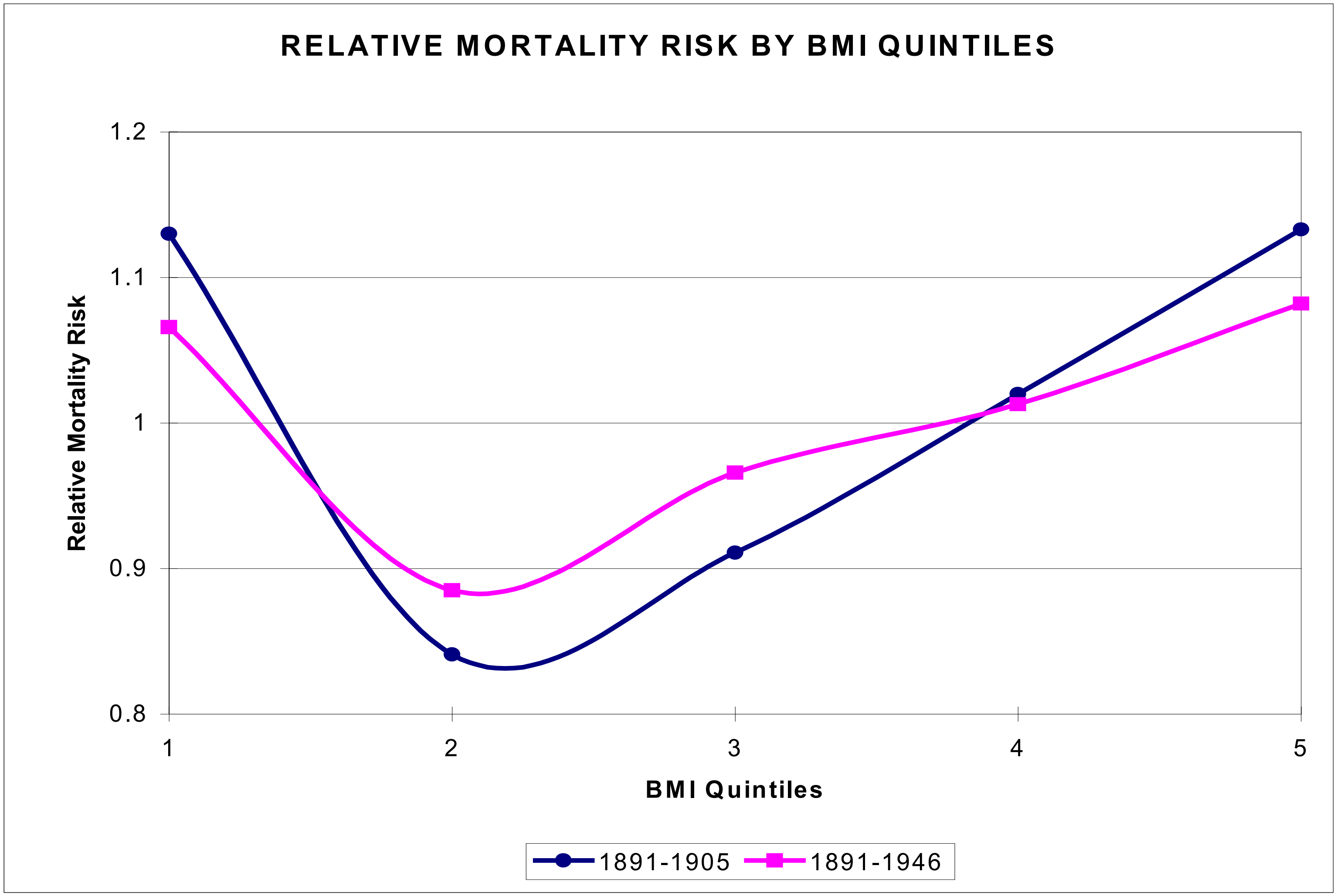

RELATIVE MORTALITY RISK BY BMI QUINTILES
Relative Mortality Risk
1.2
1.1
1
0.9
0.8
1
2
3
4
5
BMI Quintiles
1891-1905
1891-1946

Table 7

Cox Regressions for Survival Short and Long Term				
Variables	1891-1905		1891-1946	
	Coefficient	Hazard Ratio	Coefficient	Hazard Ratio
Age at Examination	0.145**	1.157	0.167***	1.182
Age Squared	-0.00063	0.999	0.00083**	0.999
BMI				
1st Quintile	0.122*	1.13	0.064*	1.066
2nd Quintile	- 0.173**	0.841	- 0.122***	0.885
3rd Quintile	-0.094	0.911	-0.034	0.966
4th Quintile	0.02	1.02	0.013	1.013
5th Quintile	0.125*	1.133	0.079**	1.082
Occupation at Enlistment				
Farmer	- 0.202***	0.817	- 0.141***	0.868
Artisan	0.016	1.016	0.089**	1.093
Professional	-0.081	0.922	-0.057	0.944
Manual Labor	0.162**	1.176	0.005	1.005
Other	0.105	1.111	0.104	1.11
Residence				
Northeast	0.061	1.063	0.090***	1.094
Central	0.035	1.035	-0.043	0.958
North-central	-0.027	0.974	-0.008	0.992
Other	-0.069	0.934	-0.039	0.962
No. of battles	- 0.086**	0.917	-0.016	0.984
Cardiovascular in 1891	0.09	1.094	0.003	1.003
No. of Diseases in 1891	0.005	1.005	0.016	1.017
Observations	3,416		3,416	
Chi-square	365.2 (d.f. =16)		871.1 (d.f. =16)	

***Significant at 1%

** Significant at 5%

*Significant at 10%