Great Britain after World War I & World War II: Studying the post-war sex-ratio imbalance

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Master’s Thesis in Demography
Master in Demography (1 year)
Spring Semester 2016

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Abstract

One significant demographic outcome of armed conflicts is the influence on the population sex ratio. The sex ratio in this study refer to number of men versus number of women. The 20th Century experienced a shift from armed conflicts with high numbers of military casualties and few civilian losses, to an opposite relationship with lower numbers of military losses but instead large numbers of civilian causalities, with a more balanced mortality between the sexes. During World War I and partly during World War II, increased mortality of young men left more women in the age ranges of the casualties, creating excess cohorts of women. The reported sex ratios relating to the two world wars were extraordinary. Sex ratios allegedly declined in almost all combatant countries, but not in the non-combatant countries. The declines were significant and substantial, and have been incomparable to subsequent conflicts. The aim of this thesis is to study how mortality in the cohort of men who were most active in World War I and World War II contribute to the sex ratio imbalance at the population level. The studied case will be England and Wales with the population effects from World War I and World War II. This is the first study that focuses deeply on this subject. Observations of the surviving soldier cohorts reveal an amplifying effect on the sex ratio imbalance on the population level. The study here addresses another type of sex ratio; sex ratio in mortality. After a severely increased mortality sex ratio during the war years and a drop immediately after the wars, post-war development for both World War I and World War II, display a regained high mortality ratio between males and females.
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1. Introduction

1.1 Motivation

One significant demographic outcome of armed conflicts is the influence on the population sex ratio. Armed conflicts with mainly male casualties causes an imbalance in the sex ratio on a population level. The 20th Century experienced a shift from armed conflicts with high numbers of military casualties and few civilian losses, to an opposite relationship with lower numbers of military losses but instead large numbers of civilian causalities, with a more balanced mortality between the sexes. During World War I and partly during World War II, increased mortality of young men left more women in the age ranges of the casualties, creating excess cohorts of women. The reported sex ratios relating to the two world wars were extraordinary. Sex ratios reportedly declined in almost all combatant countries, but not in the non-combatant countries. The declines were significant and substantial, and have been incomparable to subsequent conflicts.

1.2 Research Question

The aim of this thesis is to study how mortality in the cohort of men who were most active in World War I and World War II contributed to the sex ratio imbalance of the population level. The studied case will be England and Wales with the population effects from World War I and World War II. This is the first study that focuses deeply on this subject.
1.3 Case Selection

During the 20th Century the United Kingdom engaged in the two world wars. Countless number of casualties followed the wars from 1914 to 1918, and 1939 to 1945. Most of the combatants consisted of men in prime fertile age, as this category of young men formed the body of the British armed forces.

The population of England and Wales is an interesting case to study because these two major events created such a large sex imbalance in the population. World War I did not, in large, take place on British soil. The ground battles mostly occurred in central Europe thus exempting casualties in Great Britain. The British civil population and especially the women, suffered low number of civilian casualties in comparison to the military casualties. These losses created gaps in statistics and the society, both demographic and socially as well as culturally. The depletion of a generation of educated and privileged young men, destined to become politicians, philosophers, and poets has been called The Lost Generation. During World War II, the civilian population in Britain experienced higher mortality while the casualties of combatants were lower. Still the losses of men at prime fertile age after the two wars changed the demographic structure in Great Britain, resulting in a skewed post-war sex ratio, particularly after World War I.

1.4 Outline of the next sections

The sections of general population development in the United Kingdom and the war effects on the British population in this study will present a starting point for an empirical analysis. In order to comprehend the population dynamics that might have influenced the sex ratio in England and Wales during the 20th Century, aspects of fertility and migration will briefly be reviewed in the section of potential amplifying or rebalancing factors. In the empirical section, longitudinal data will be examined from as far back
as 1869 to isolate the extent of the sex ratio imbalance. The years leading up to World War I and World War II will be studied in order to establish demographic trends and projections prior to the war outbreak. In order to explore the mortality sex ratio among cohorts born during the interwar period, longitudinal analysis will cover cohorts born as late as 1934. To fully understand the sex ratio imbalance at the population level, development over the 20th Century will be shown, which has not been done using the most recent and best data. The main empirical analysis will establish if the mortality of the surviving soldier cohorts worsened or improved the sex ratio imbalance.

1.5 Definition of population and sex ratio

Population is defined as individuals living in a certain country. A population may increase, decrease or be kept stable in processes through births, deaths and migration (Weeks, 2011). In most populations the number of males and females are fairly even with slightly more females due to lower mortality rates. Population sex ratio is a measure for studying the proportion between sexes. Sex ratio refers to the total number of males for every 100 females in the population. The sex ratio depends on three factors: the sex ratio at birth, differential mortality rates between the sexes at different ages, in addition to losses and gains through migration. In general, more males are born than females even though male foetuses are frailer. Males are more sensitive to diseases and are more likely to be exposed to risk and violence. Meanwhile, females experience longer life expectancy and are less likely to be exposed to risks and violence. Under equal conditions in terms of nutrition and health care, females have lower mortality in all age groups. A European study of births in 24 countries showed a sex ratio of 105 - 107 boys born to 100 girls, with a median of 105.9. This figure has been widely used as the baseline for calculating deviations in the sex ratio (Hesketh & Xing 2006, p. 13271). If all births were to be counted, including still births (due to less resistance among male
foetuses), the sex ratio would be even higher. For the 20th century, the British sex ratio at birth average was 105.4.
2. General population development in the United Kingdom

The United Kingdom was the European supremacy at the start of the 20th Century. The years of industrialization had developed Great Britain and the economy was strong. The British empire held power over one-fifth of the World’s population at the time and covered almost a quarter of the Earth’s total land area. However, social and economic turmoil would arise in Britain with World War I. During the war, the United Kingdom lost around 725,000 soldiers together with 16,000 civilians (of the majority being men). At the end of the war, the pandemic *Spanish Flu* also struck the population in Britain. Furthermore, Great Britain suffered from the recession between 1920 and 1930 with high levels of unemployment and poverty.

Demographic transition is the theory developed by Warren Thompson in 1929. Based on an interpretation of demographic history it refers to the transition from high birth and death rates to low birth and death rates as a country advances from a pre-industrial to an industrialized economic system (Weeks, 2011). At the end of the 19th Century, England and Wales had progressed through the third stage of the demographic transition. The third stage is identified with a decline in birth rates. In 1871 the average British woman was having 5.5 children but by 1921 it had dropped to 2.4 children. Between 1895 and 1913 annual birth rates fell from 30 to 23 births per 1000 persons (McKay et al., 1999, p.822). Infant mortality in England and Wales dropped considerably from 1861 over the following hundred years, mainly due to improved control of commu-
cable diseases. Infant death rates dropped from 160 to 20 per 1000 live births, during the same time span (Weeks, 2011, p.162). Improved health care at the end of the 19th Century also created a higher survival rate among new born (especially males), further increasing the sex ratio (McKeown et al., 1972).

The fourth stage implies low birth rates in combination with decreasing death rates and consequently a slowdown in population growth. Great Britain entered the fourth stage of the demographic transition by the turn of century, and continued throughout half of the 20th Century. Even though the British population continued to grow at the beginning of the century, but the growth rate had declined considerably (Jefferies, 2005). Both male and female death rates continued to decline in England and Wales between 1901 and 1910. After 1910, the female death rate fell more than the male rate. These differences highlight the need to consider the factors which have tended to inflate male mortality as well as the factors which have contributed to reductions in female mortality (Harris, 2008).

Figure 2.1: Warren Thompson’s Demographic transition model with the four stages. (Jefferies 2005, p.5)
Life expectancy started to rise before World War I. Remarkably, it continued to improve during the war, and three years after the war life expectancy for women was 60 years and 56 years for men. Also the overall standard of health improved during the years of war (Winter, 1986, p106).

Nevertheless, change in lifestyles may cause a regression in improved life expectancy. Tobacco smoking had prior to World War II almost exclusively been attributed to men. After World War II more women started smoking and eventually becoming just as frequent as men. In turn, deaths connected to smoking increased among women. Subsequently, the gap in male-female tobacco related mortality narrowed (Weeks, 2011, p.165).
3. War effects on the British population

3.1 What is known about mortality in World War I and World War II, and the sex ratio imbalance that was created

Both World War I and World War II caused immense military and civilian casualties among the British population. During World War I the number of casualties among combatants were multiple times larger than the casualties among the civilian population. During World War II, the number of casualties among the combatants was then lower than World War I, while the civilian losses were much higher.

The population in Great Britain in 1914 was close to 35 million. Over six million British and Irishmen served in World War I. Most casualties were part of the armed forces. Nevertheless, civilian losses still occurred. Over 15,000 crews and passengers of merchant or fishing vessels and over thousand civilians died as a result of air and sea bombardment (a majority of the victims were men). Great Britain was basically the only participating country with such large military-civilian death ratio (Winter, 1986). The total number of casualties during World War I have been contested (Winter, 1976, p.539). However, the most accepted figure is of 723,000 killed British combatants. These figures are based of military and naval sources (Winter, 1986, p.80). Of all mobilized men, a staggering 12.3
percent were killed. War-related mortality was greatest at age 20 (Prost, 2013, p.566). Of the British combatants under age 30, half a million were lost in the war. If the group of men killed during World War I is singled out as a percentage of the total male population aged 15 to 49, the losses were 6.7 percent of that age group. In combination with limited civilian losses and even lower number of women in fertile age, the result formed a large imbalance in the sex ratio. The imbalance after World War I could still be observed in the 1961 census (Winter, 1986, p.74). In figure 3.1, combatant casualties and the war-related deaths for World War I is shown. Noticeable is the increase in number of deaths as the war continued.

![Figure 3.1](image)

**Figure 3.1:** Total war-related deaths during 1914-18. (Winter, 1976, p.547)

Figure 3.2 shows the age distribution among serving men and the causalities. These figures are based on a, at the time, widely popular insurance company’s records. The discrepancy from the military records is large, but still the figure reveals a heavy toll on the age group 20-24 year olds (Winter, 1986). 16 percent of the population in that age group were depleted in World War I. The figure also shows the population of each age group. These were the men eligible for military service according to their age (18
to 41). The heavy casualties of young combatants in World War I led to the term *The Lost Generation*. Back in Britain waited the new category of *Surplus Women*, numerous women that were unemployed and unable to marry in the absence of available men (Holden, 2007). Among officers and non-commissioned officers were many recruited from schools and universities. Casualty rates among this group were higher than for men in the ranks, due to the routine of leading soldiers in assaults out of the trenches (Winter, 1977). At the end of the 1940s, *The Lost Generation* were ageing, while the *Surplus Women* were experiencing higher marriage and employment rates (Holden, 2007).

![Figure 3.2](image)

*Figure 3.2:* The age distribution of the participating combatants in World War I. (Winter 1977, p.451)

Total deaths in the United Kingdom during World War II have been estimated to be about 450.000, of these almost 70.000 were civilians (Kesternich et al., 2014, p.106). The population at the beginning of the war was roughly 38 million. Most of the civilian deaths were caused by six years of aerial bombings. In addition to the deaths, nearly a quarter of a million suffered from injuries (Harris, 1992). Initially men between 18 and 41 were eligible for military service through the conscription laws. In 1941, obligation
to undertake some form of national service was increased to age 60. Unmarried women and childless widows between 20 and 30 were also eligible to join the women’s Forces, including taking on industrial labour positions (Gowing, 1972).

In addition, multiple English colonies of the Commonwealth sent soldiers to fight for the United Kingdom during the battles of the war. Among the colonies, India was likely the largest contributor of soldiers with close to 400,000, but in addition also losing one-tenth of them. Most of the colonial soldiers participated in the campaigns in North Africa and the Middle East. However, many of them also served in the European campaigns, mainly in Italy (Sherwood, 1997, p.13).

Figure 3.3 shows the mortality rate in Great Britain during the 20th Century. The two world wars are apparent when observing the mortality rates among men. For both wars, a rapid increase in mortality rates is evident. The peaks of mortality occurred towards the end of both wars (among civilians, the peak was in the beginning of World War II). Immediately after the wars had ended, the death rates for men dropped. For both sexes, the demographic transition’s second and third stage of decreased death rates, are noticeable after the turn of the century.

Since mostly men died during both World War I and World War II, low male to female ratios emerged after the wars. The next section will look at factors that could help reduce the sex ratio imbalance.
Figure 3.3: The mortality rates in Great Britain during the 20th Century. (Lindsay 2003, p.135)
4. Factors that could rebalance the sex ratio

4.1 Fertility

It is claimed that "during and immediately after major wars, more sons are born than usual in the belligerent countries as if to replace the men that died" (Ridley, 1994, p.123). This phenomenon is known as the Returning Soldier Effect. A small excess of male births has been reported to occur during and after war. The effect could help rebalance the sex ratio. The finding of a small but significant increase in male births during and after war has been well established for World War I and World War II. There is no clear explanation for the Returning Soldier Effect phenomenon. Multiple demographic and environmental factors have been studied without leaving a commonly accepted solution (James, 2009, p.116).

Jan Graffelman and Rolf Hoekstra (2000) have studied war effects on human sex ratio in numerous European countries with focus on effects from World War I and World War II. Their results show a slightly higher sex ratio among live births in the United Kingdom.

England and Wales experienced an increase in the sex ratio at birth in both wars. The occurrence differed however. For World War I the increase in the birth sex ratio occurred at the end of the war, whereas the increase started already in 1941 for World War II. The increase was also larger than for World War I. During World War II and immediately
after, England and Wales had a higher live birth sex ratio than ever before. Explanations for the increase through changes in parity (birth order), maternal age, birth interval or foetal death rates are not sufficient enough to explain the increased sex ratio (James, 1986). However, one possible explanation for the increase after World War I is linked to social status. At the time family size were smaller in higher social classes compared to lower social classes. "...the index decreases in size with descent in the social scale. The correlation may merely be due to the fact that in the higher social class the size of families is relatively small and in small families the sex ratio of births is high." (Russel, 1936, p.400).

Although the increased sex ratio at birth has been demonstrated already in the case of England and Wales, the established difference have been so minor that it could not have influenced the sex ratio imbalance on the population level. For example, in 1941, 357217 boys were born to 338509 girls. This give a birth sex ratio of 105.5. An increase in the birth sex ratio to a high 106.5, with the same total number of births, would give an additional 1595 boys.

4.2 Migration

The British population would have grown even more rapidly during the demographic transition had it not been for increasingly large numbers of out-migrants leaving the country. The emigrants consisted of mostly young men. (Migration Watch UK) Britain with its many colonies sent large number of men to govern the dominions and to increase the labour force within these. During the century prior to World War I, altogether it is estimated that as many as 21 million citizens had emigrated from the United Kingdom (Pooley & Whyte, 1991). Most of the emigrants had voluntarily left and had been aided
in the resettlement by various associations and societies. An institutional framework for assisted migration of women already existed. Since 1884, the British Women’s Emigration Association had sponsored working class women and distressed gentlewomen to settle overseas. (Kennedy 1988)

After World War I women exceeded men in Britain by between one and a half to two million. These "surplus" women were viewed to be unused resources, destined to be unmarried and childless. Women had taken over many positions in the absence of men during the years of World War I. After the war had ended, men returned to reclaim the work leaving the former employed women without work. The number of unemployed British women subsequently rose. The 1921 census reveal that there was even a lower percentage of females working than there had been in 1911 (Wall, 2012). The settler colonies already experienced an excess of men and occupational opportunities (Kennedy, 1988). Women were needed in the colonies not only to balance the sex ratio, but also to appoint labour positions within fields of nursing, education and agriculture. In order to ease the gender imbalance and reduce the surplus of women, as well as decrease unemployment in Britain, the government increased its effort to assist in relocation as part of a social reform (Pooley & Whyte, 1991). In 1918, the government established the Oversea Emigration Committee. During the same year the British parliament passed an emigration bill in support of sending women abroad for work and family building. Among groups targeted for assisted emigration, unmarried women headed the list (Kennedy, 1988, p.407). With the Empire Settlement Act in 1922, substantial grants were allocated to support emigration in order to reduce the large unemployment rates in Britain. Over 400,000 citizens were provided assistance by the act during the following thirteen years (Pooley & Whyte, 1991). However, after World War I had ended many men also emigrated to the dominions. In 1920 125,000 women emigrated in addition to 115,000 men. Three years later even more men than women emigrated (Wall, 2012).
World War II also brought a large contingent of European refugees and prisoners of war to Britain. Among these, nearly a quarter of a million, many of them Polish, acquired permanent British citizenship. As the war proceeded, two million American and half a million Canadian troops were stationed in Great Britain. In addition to the refugees and the foreign troops, there was a temporary migration of workers and servicemen from the colonies in the West Indies (Harris, 1992, p.35).

Although partly balanced by in-migration from other countries, there was net out-migration from England in every decade between 1840 and 1930. During the recession it reversed as migrants returned home, and following World War II there was noticeable immigration from the Commonwealth countries. As a result, there was net inward migration from 1931 to 1961 (Lindsay, 2003, p.135). During the first half of the 20th Century around two percent of the British population were foreign born. After World War II, "immigration increased, but this did not have a marked effect on the size of the foreign born population between the 1951 and 1961 census, with the number only increasing by about 225,000." (Migration Watch UK).

How these migration flows contributed to the sex ratio imbalance cannot be explored further because of insufficient data. The statistics of migration throughout most of the 20th Century is simply not detailed enough.

4.3 Mortality

The following section will review mortality as potential pathway as a rebalancing factor on the population sex ratio. Put simply, to rebalance the sex ratio, female mortality rate
for would have to increase but not for males. To amplify the imbalance, the mortality rate would have to increase only for males.

A rebalanced gap in a skewed sex ratio through mortality could be explained by higher mortality rates of females from birth (where usually male foetuses are more frail than female foetuses), to adulthood (where males normally are more exposed to risks), to advanced ages (where females generally outlive males of the same age) (Weeks, 2011).

A condition with an already existing imbalanced sex ratio experiencing an increasing gap through mortality, could be explained by higher mortality rates of males (in settings where it is expected to be the opposite). It could also be explained through female mortality rates decreasing faster than male mortality rates.

4.3.1 Post-war mechanisms of soldier cohort as a rebalancing factor

This section will look at the possibility of the surviving soldier cohorts contributing to rebalancing the sex ratio imbalance through the different patterns of post-war mortality, compared to cohorts not involved in war due to being too young or too old at the time. Possibly the most influential factor has been the Civil status effect. With the cohorts studied, more women than men would certainly pose a higher chance for the soldier cohort of getting married, whereas the women in that cohort should have been more unlikely to be married because there were not enough men. Changes in marriage opportunities may have a differential mortality for men (lower) and women (higher). "The marriage squeeze, or the effect on marriage of an imbalance between the numbers of males and females, has been seen as having a great influence on contemporary marriage behaviour." (Schoen, 1983, p.62). It is well known that men in a union tend to live longer than unmarried men. The two most popular possible explanations are that
the marriage itself promotes a healthier lifestyle than the lifestyle of unmarried men. The second explanation is that healthier men have a higher tendency to enter a union, suggesting that healthier men already have a higher life expectancy (Drefahl, 2012). Both sexes in a marriage generally experience lower mortality rates, although this benefit is stronger for men. The lifestyles of unmarried men may increase risky behaviour, thus exposing to higher risks. Unmarried men have a significantly higher occurrence of suicide both compared to married men and unmarried women (Weeks, 2011, p.193). In addition, divorced, never married or widowed men have a higher mortality rate than married men (Lee & Panis, 1996).

The shortage of available men for the surplus women caused a lack of marriage opportunities during the interwar years. Among the large group of unmarried women many were involuntarily childless. Out of wedlock births were at the time not particularly common and were frowned upon. Studies have shown that mortality rates are higher among childless women. One study claimed that childlessness increases not only the risk of premature mortality, but also for psychiatric illness (Agerbo et al., 2012).

4.3.2 Post-war mechanisms of soldier cohort as an amplifying factor

This section will look at the possibility of the surviving soldier cohorts contributing to amplifying the sex ratio imbalance through the different patterns of post-war mortality. The mortality among the surviving soldier cohorts together with the mortality among the men who stayed behind during the two wars could potentially have increased the sex ratio gap by experiencing higher mortality rates than unaffected cohorts.
Health status

In the beginning of World War I, numerous men, (of many being bachelors), volunteered to serve. The age ranges were generally between 19 and 41. Many of the casualties during the beginning of the war consisted of young men from well-off families since many men from the working class often were too unfit for military service (Holden, 2007). Although men in the working class had more physical professions, many men of the enlisted were more fit than the group that were never called upon. The working class group already experienced a high mortality rate due to the harsh working conditions, with labour positions such as pottery and street workers. Among five million in the relevant age group, as many as one-third were deemed either too unfit or exempted from military service (Winter, 1986). This selection process would indicate that among the healthier groups in society, the same group suffered more casualties during World War I. This would subsequently lead to that the unfit group became larger after the war, leading to a lower overall life expectancy on the population level due to poorer health status.

Figure 4.1 presents the distribution of members of the armed forces by profession. Among the fields of Finance & Commerce, Professions, and Entertainment war participation was higher than other profession. As mentioned previously in the text, many of the first who volunteered came from the educational system, the finance sector and the civil service.

War related injuries

Besides all casualties, countless soldiers and officers returned after World War I with significant injuries and mental wounds. It is likely that among the 1.6 million injured returning soldiers were males unable to reproduce due to various injuries, in addition of likely higher suicide rates and lower life expectancies. "Many of those who survived
the war spent the next two or three years watching their fellow soldiers being wounded or killed, and those lucky enough to emerge without physical scars were still often left in shock, mourning for lost comrades and alienated from potential marriage partners." (Holden, 2007, p.11). Historian Jay Winter (1986) argues that the returning soldiers experienced higher mortality rates in comparison to the men who did not take part in World War I. He calls this cohort of prematurely aged veterans a Burnt-out generation. Roughly 1.2 million veterans were entitled to disability pensions. One-third had severe disabilities among this group. He also claims that some of the diseases the soldiers had been exposed to during the war such as tuberculosis or malaria, had reduced their resistance to other endemic diseases. This could possibly have led to a shorter life expectancy and higher mortality rates within this group.

Studies of American World War II veterans with combat experiences or postings overseas showed higher mortality rates compared to males who had not participated in the
war or fellow soldiers who had served on the home front. Some of the mortality rates have been linked to excessive alcohol consumption (Elder, 2009).
5. Data

All data used in this study has been retrieved from the Human Mortality Database. The database was created to provide detailed mortality and population data to researchers, students, journalists, policy analysts, and others interested in the history of human longevity. The data mainly consists of censuses, lists from the General Register Office for England and Wales, His Majesty’s Stationery Office, the Office for National Statistics and the work by Jdanov, Andreev, Jasilionis, and Shkolnikov. Data for England and Wales are available for the total population as well as the civilian population. The period data in the two series differ only for the years between the pre-war and post-war censuses (1912-1920 and 1939-1950). The data cover the total population including both civilian and military regardless of whether the death occurred abroad (HMD; Jdanov et al., 2005). Since 1801, a census has been taken in Great Britain every 10 years, except in 1941 during World War II. From the 1920s onwards censuses were taken in slightly different intervals (Mitchell, 1988).

The data used was organized in annual counts of births, deaths and population size for Total Population, England and Wales, with births, deaths and population size series, 1841 to 2013. From these tables, the years 1841 to 1868 and 2000 to 2013 were extracted, leaving data for 1869 to 1999. The information gathered from the times series for births presents the number of girls and boys born, as well as the total per year. The time series for deaths show the number of deaths, separated by sex, for each age per year up to age 110+. The table for population show the number of females, males and total population at every age per year. The death rates were obtained by dividing the number
of deaths with the number of the exposure-to-risk (the number of the same population group) and multiplied by 100. Estimates of the population exposed to the risk of death are based on annual (January 1st) population estimates.

In addition, cohort data was used with death rates 1842 to 1983. Tables with age times one-year intervals were used. Each series was in one year and age intervals and sorted by year, age, females, males and total population. All series were last modified on the 27th of July 2015. Calculations were either done using Microsoft Excel or Stata 13.

The cohort deaths were retrieved from the deaths by lexis triangles of the Human Mortality database. A filter in Excel was used in order to separate the lexis triangles with the formula; year minus age minus cohort. This gave either 0 or 1 and separated the two groups.
6. Empirical results

6.1 Describing the mortality related to war and the sex ratio imbalance that emerged

In order to determine the effect on the age groups that suffered the most casualties and the impact on the sex-ratio after the war, it has to be determined how great losses in each age group were. The lack and inaccuracies of records and statistics create challenges of determining the age structure of the war losses (Winter, 1976, p.552.)

Figure 6.1 shows the sex specific share on the total number of deaths for World War I together with two years before and two years after for comparison. The blue bar represents the proportion for males. The proportion is calculated by dividing the number of male deaths with the total number of deaths in the population, then multiplied by 100. The red bar represents the proportion of females. The female proportion is then 100 minus the male proportion. The calculations are done for each year between 1912 and 1920. The specific share is then separated by six different age groups, ranging from 18 to 40 year olds.

Two age groups stand out, the 18-22 and 23-26 year olds. These two age groups experienced a large male to female death ratio. Also noticeable is the increased death sex ratio annually. 1916 and 1917 were the two worst years among men in all age groups, in terms of death sex ratio. 1918 was still the worst year for total deaths among men. In the
two years before and after the war, the death ratio in all age groups is nearly balanced between males and females.

Figure 6.1: Sex specific share of total number of deaths by age group between 1912 and 1920.

Figure 6.2 shows the sex specific share on the total number of deaths for World War II together with one year before and two years after for comparison. The two youngest age groups again had the highest death sex ratio. This sex ratio continued to increase throughout the war. The figure shows that the last year of World War II, 1945, experienced the largest sex ratio in deaths. The years before and after the war, 1938 and 1946 respectively show a balanced sex ratio in deaths.
Figure 6.2: Sex specific share of total number of deaths by age group between 1912 and 1920.

Figure 6.3 shows the death toll by sex of World War I on the British population. The deaths are in absolute numbers. It is noticeable how much mortality increased during the first year of war. Bear in mind that the war began after half of 1914 already had passed. The deaths among males continued to increase every year during the war. The highest number of deaths occurred during the last year of World War I. Note that the figure includes all deaths in the population, both war-related and the ordinary deaths in the civil population. The large amount of female deaths in 1918 is related to the Spanish Flu epidemic. In 1920, the deaths were balanced and nearly at the same levels of the
pre-war years.

Figure 6.3: Number of deaths by year, 1912-1920.

Figure 6.4 shows deaths in absolute numbers of World War II with one year before and two years after. Figure 6.4 was created using the same method as for Figure 6.3. The figure shows a lower number of male deaths in relation to World War I. The female deaths are higher for the reason previously presented. With the exception of 1940, every year during the war experienced an increase in deaths among males. For females, with the start of 1940, there was a decrease in deaths even though Great Britain suffered from German bombardments and food rationing.
Figure 6.4: Number of deaths by year, 1938-1946.
The excess of females is presented in Figure 6.5. This was calculated by adding all ages (0-110+) per year by females and males. Ages 65 to 110 were then extracted. Finally, the number of females was subtracted with the number of males in order to present the excess females. As seen in figure 6.5, the 20th Century started with an excess of females under 66 years. The beginning of World War I is noticeable, as well for the increase as the war continued. The sex ratio imbalance gradually improved after World War I. The peak occurred at the end of the war, and subsequently dropped afterwards. The sex ratio decreased again with the beginning of World War II. The sex ratio altered during the war with the losses of civilian lives due to aerial bombings over several cities in England. 1940 revealed a sudden influx of males. This inflow is unexplained in the literature. Nevertheless, the most likely explanations would be the arrival of refugees in Great Britain in the beginning of the war, or citizenships given early (It might also be related to the absent census for 1941). After the end of World War II the sex ratio gap rebalanced at a higher pace than after World War I. Around 1966 the sex ratio imbalance had finally rebalanced. After 1967 the excess of women was replaced by an excess of men that continued to increase until the peak in 1981. Thereafter the gap continued to rebalance.

6.1.1 Analysis of post-war soldier cohort mortality to understand whether there was an amplifying or rebalancing effect

This paragraph will introduce another sex ratio; sex ratio in mortality. In all following diagrams, the sex ratio in mortality is shown. In figure 6.6 the mortality sex ratio is shown through three different birth cohorts. The x-axis represents the age, while the y-axis represents the ratio between men and women. A value above 1 means that males are experiencing a higher mortality than females. The choice of cohorts has been made in order to show a distinction between the participating cohorts and the non-participating
Figure 6.5: Excess female of total population of ages 0 - 65.
cohorts. The separating factor are the ages in the cohorts. Two cohorts have ten year intervals while one cohort have a five year interval. This will present a more justified picture with the separation by affected age groups. When World War I began, the cohorts were differently affected by the war. The first cohort of men and women born between 1870 and 1879 were not particularly affected by World War I in terms of mortality. The second cohort of men and women born between 1880 and 1884 were affected to a greater extent, but the exposure was limited to a ten year age range between 30 and 40. When World War I began, the people in the cohort were between the ages of 30 and 34. The 1890-1899 cohort; the soldier cohort, was affected the most. It is evident when observing the ages 16 to 28. The men of this cohort formed most of the British armed forces during World War I. Men and women in this cohort were in the ages 15 to 28 during the war years. After the age of 30, an increase in mortality sex ratio slowly began and continued to the mid-sixties. The men and women of this cohort were in the ages between 40 and 56 when World War II began.

In all, mortality was higher for the soldier cohort at every age after the war. The previous cohort with some exposure to war also experienced higher mortality at every age compared to the first cohort with little or no exposure to war.

The sex ratio of age specific mortality was plotted for the 1870-1879 birth cohort, i.e. the pre-war comparison group, the 1880-1884 birth cohort, and the 1890-1899 birth cohort i.e. the soldier cohort, across their whole lives. The Y axis is the sex ratio, and the X axis starts at age 0 and counts each age until the entire cohort has died out. To calculate the cohort deaths, lexis triangles are used. Two different ages but born in the same year were added. The 1870 one-year olds’ deaths minus the 1870 one-year olds’ (who were born in 1869) deaths minus - 1870 two-year olds’ (who were born in 1869) deaths. This calculation gives the 1870 two-year olds. Subsequently this is done
Figure 6.6: Mortality sex ratios related to WWI, cohorts 1870-1899.
with the following cohort years.

In figure 6.7, the mortality sex ratios related to WWII are shown with two different birth cohorts. The first cohort have a eight year interval while the second cohort have a five year interval. This will present a more justified picture with a separation by affected age groups. The Y axis is the sex ratio, and the X axis starts at age 0 and counts each age until the entire cohort has died out. Figure 6.7 was created using the same method as for Figure 6.6. The 1913-1920 cohort, i.e. the soldier cohort, displayed a large effect from World War II. During the initial phase of the war, the men and women of the cohort were in the ages between 19 and 26. Among this age group were the men who constituted the main body of the British armed forces. The 1930-1934 cohort, i.e. the comparison cohort was not heavily affected by World War II, excluding the civilian casualties during the war under the age of 15. After the war, this cohort experienced a rapid increase in the mortality sex ratio at around age 19, followed by a slow decrease. This cohort had slightly higher mortality than the soldier cohort up to age 22, and again between ages 33 to 47. After age 50, the soldier cohort displayed higher mortality at all older ages.

The mortality sex ratio is not as vast as for the cohorts affected during World War I since the military losses were much lower while the civilian losses much higher. Very similar to the most affected cohort in World War I, the World War II soldier cohort was the most affected cohort from World War II an increasing mortality sex ratio from the early thirties.
Figure 6.7: Mortality sex ratios related to WWII, cohorts 1913-1934
7. Discussion

It would be fair to say that the returning soldier cohorts had an impact on the population levels after World War I and World War II. The difference and the impact of the two wars were disproportionate. Even if World War II affected the whole population of Great Britain, World War I created a greater impact on the population level with the large mortality sex ratio caused by the war. It would also be fair to conclude that the returning soldier cohorts (especially after World War I) had an amplifying effect on the sex ratio imbalance. This is evident when observing the soldier cohort post war mortality sex ratio. Since these cohorts continued to have a high death sex ratio, the already existing sex ratio imbalance was amplified. It would also be a conclusion to state that the sex ratio imbalance never really rebalanced. The rebalance among the World War I soldier cohorts only occurred when this generation entered advanced ages and died of age. The life expectancy figures of the soldier cohorts of World War I coincide with the decline of excess female in the sixties. Many of the surplus women after World War I continued their lives unmarried and childless.

The soldier cohorts of World War II did not really experience a sex ratio imbalance caused by the war. The effects of the war were simply not that large on the sex ratio. The number of male casualties compared to the number of female casualties put against the population of the time, reveal only a slight impact on the sex ratio at the population level.

The foremost mechanism in explaining the sex ratio gap alternation is mortality. Never-
theless, with more detailed data a more comprehensive study could be done for migration. With such data it would be possible to examine the inward and outward migration based on sex. What is known is the deficiency of migration records. Movements between commonwealth countries were not necessarily recorded. In addition, registering movements at ports and airports during the first half of the 20th Century were many times insufficient. The literature states that periodically more women than men emigrated from Great Britain, but during a longer timespan outward migration was represented by more men than women. What would be interesting is to study the in-migration to Great Britain. An in-migration with an inflow of more men than women could partly account for a reduced sex ratio gap in Great Britain after the two wars.

The underlying factors of the post war mortality among the soldier cohorts of World War I should be examined further. The health aspect among the former soldiers is an important factor that needs to be considered. It is quite possible that the selection of men for enlistment had a negative effect on the post war health. With more detailed data, it would be possible to examine the health factor in depth. Unobserved heterogeneity in the selection process of eligible males for enlistment could have had a negative effect on the population rebalance. The group that were too unfit continued their lives in Great Britain, but should still have a shorter life expectancy than the soldier group, due to their (confirmed) poorer health. This would mean that the group of men that were exempted from military service (due to various occupational positions or obligations) should be a suitable reference group in comparison to the soldier group. This exempted group should have had an average health status since the men in this group were not excluded due to fitness and had various occupations (not necessarily affecting their health). It would be expected to see that the soldier group should initially have had a slightly higher health status than the reference average. After the war it would be expected to see that the war had affected the health in the soldier group in a negative way (due to
duress, injuries etc.)

It is important to remember that even if the casualties during World War I "merely" represented two percent of the total British population (and even less in World War II), the losses represented a larger effect since the group represented men in prime fertile age. Even before the war, Great Britain experienced a surplus of women. The war itself created a larger sex ratio imbalance, generated even more excess of women.

There are a number of other conflicts with a large sex ratio mortality imbalance that could be studied and compared to England and Wales during World War I and World War II. France and Serbia for example, also experienced a large imbalance between military and civilian casualties during World War I. During World War II, Finland had villages where entire male populations were killed. The 1975-1990 civil war in Lebanon, generated a large sex ratio imbalance.

Calculating the mortality during and after armed conflicts with the method used in this study can be applicable in other cases if the data is detailed enough. Modern conflicts are complexed, unconventional and often feature enormous civilian casualties. With detailed data it is possible to calculate the effects on the population level as well as to observe the consequences for the demographic structure. These types of observations may help the humanitarian community to recognise what kind of aid, investments or policies that should be implemented after conflicts (and possibly already during a conflict). The assessment at the population level should be done by considering the mortality occurring in the conflict area, as well as the out-flow migration. These two mechanisms have a large effect on the population composition in addition to the post-war fertility.
Acknowledgements

I would like to express my utmost appreciation to my two supervisors Sunnee Billingsley and Sven Drefahl for their great support during my writing. I would also like to thank Anna-Maria Guzman for correcting my English, Francesco Rampazzo for his technical guidance and Anders Hellström for forming the original idea with me in 2009.


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