The contribution of alcohol use and smoking to the gender gap in life expectancy in Central Asia between 1981-2017

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Abstract

Background: Gender differences in alcohol consumption and smoking play a role in the gender gap in life expectancy and have an apparent advantage for women, but little is known about this in Central Asia. Examining the gender gap in life expectancy can reduce mortality differences and identify societal gains. The objective is to explore the impact of alcohol use and smoking on the gender gap in life expectancy in Central Asia and how this is changing between 1981-2017.

Data and Methods: To calculate gender differences in life expectancy and alcohol- and smoking-attributable mortality, the WHO mortality database was used with population, all-cause mortality, and cause-specific mortality data. Life tables were calculated for Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan for the period 1981-2017 and were afterwards decomposed into the contribution of alcohol- and smoking-attributable mortality. Using the alcohol cause-specific fractions from the GBD alcohol-attributable mortality was estimated. Using WHO lung cancer mortality data and the Peto-Lopez method, smoking-attributable mortality was calculated. The Arriaga decomposition technique was used to calculate the contribution of alcohol and smoking to the gender gap in life expectancy.

Results: Central Asian women live on average 6.1 years longer than men in the most recent situation. The average gender gap in life expectancy within the countries and research period ranges from 10.1 years (Kazakhstan) to 4.7 years (Tajikistan). Over time the gap showed subsequently a decrease, an increase, and a slight decrease again. In the most recent situation alcohol-attributable mortality accounts on average for 1.30 years (21%) of the gender difference in life expectancy and smoking-attributable mortality for 1.21 years (18%). In Kyrgyzstan, Tajikistan, and Uzbekistan the contribution of alcohol is bigger and in Kazakhstan and Turkmenistan, the contribution of smoking is bigger. Alcohol-attributable mortality first showed a decrease and subsequently increased and decreased again. Smoking-attributable mortality remained more stable at first and decreased in the 1990s. The contribution of alcohol or smoking-attributable mortality followed a similar trend in all five countries, but differences between them are large. Kazakhstan is having the highest absolute and relative contributions and Tajikistan the lowest.

Conclusion: Even though the gender gap in life expectancy at birth is decreasing in Central Asia, women live on average 6.1 years longer. The gap in life expectancy can for 21% be explained by alcohol use and for 18% by smoking. Addressing the difference in male and female smoking patterns and especially alcohol use will help decrease the gender difference in life expectancy and country differences must be considered when conducting future research or formulating new policies.

Keywords: Gender gap in life expectancy, alcohol use, smoking, mortality patterns, decomposition

List of abbreviations

CVD	Cardiovascular diseases
GBD	Global Burden of Disease
ICD	International Classification of Disease
IHME	Institute for Health Metrics and Evaluation
UN	United Nations
USSR	Union of Soviet Socialist Republics
WHO	World Health Organisation

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1. Introduction

1.1 Background

On a global scale, women tend to grow older and outlive men at all ages and this so-called gender gap in life expectancy is relatively large in Central Asia (defined as Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan by the World Bank and the UN) (Baksaikhan et al., 2017). The World Health Organisation (WHO) (2018) has marked cardiovascular diseases (CVDs) as the number one reason for the gender gap in life expectancy. In 2005 and 2010 the WHO stated that on a global level, alcohol use and smoking are a serious health burden that affects many, if not all people, causing this increase in CVDs and other non-communicable diseases. Non-communicable diseases related to lifestyle are also rising in the top 10 causes of deaths in Central Asia and CVDs form by far the biggest share of deaths (WHO, 2018). This rise in non-communicable diseases related to alcohol use and smoking patterns may explain the differences in life expectancy between men and women and different research in western countries has shown that part of this gender gap in life expectancy is indeed due to these behavioural factors and lifestyle choices (i.e., Bobak, 2003; Rogers et al., 2010; Luy, & Wegner-Siegmundt, 2015; Kolip & Lange, 2017; Trias-Llimós & Janssen, 2018; Janssen, 2020a). The studies showed that alcohol use and smoking contribute to this gender gap in life expectancy leading to lower life expectancy among men.

When zooming in on Central Asia the demographics of the region have changed after the fall of the USSR, resulting in an increase in life expectancy since the beginning of the 2000s (Gentile, 2005; Baksaikhan et al., 2017). According to the World Bank (2021a) and WHO (2021a), the expected average age at death in Central Asia was around 64 in 2000 and around 73 in 2020, which means that over the past two decades life expectancy increased by approximately nine years. This trend is visible for both males and females in all five countries. However, the rate at which this occurs differs significantly, resulting in a substantial difference in life expectancy rate between genders. For example, in Kazakhstan, the difference in life expectancy between genders is almost 10 years (Baksaikhan et al., 2017). Furthermore, mortality in Central Asia which is related to non-communicable diseases and associated with behavioural factors, such as alcohol consumption and smoking is increasing. Lifestyle choices are one of the main reasons for the increase in mortality differences, and excessive alcohol use and heavy smoking are not uncommon in this region (Cockerham et al., 2004; Guillot et al., 2013). n Uzbekistan, the country that has the highest life expectancy rate in the region, there is an increase in CVDs, malignant neoplasms, and chronic respiratory diseases, which can be associated with alcohol consumption and smoking (Nikadambaeva & Akhmedov 2020; Shamiev, 2020). In addition, Guillot et al. (2013) found a rise in male mortality which was triggered by alcohol-related accidents and diseases among middle-aged men in the working class in Kyrgyzstan. Similar trends occur in all Central Asian counties, in which both total alcohol consumption and drinking patterns play a role (Jakab et al., 2014; Davletov, 2015; Aringazina et al., 2018; WHO, 2018). Mortality rates amongst females who smoke are also in line with this trend. This is due to the substantial increase in women smoking after the collapse of the USSR and resulted in an increase in CVDs and lung cancer within the female population (Gillmore et al., 2004; Roberts et al., 2012). Not only smoking itself is contributing, but also the use of smokeless tobacco, exposure to smoke and second-hand smoke, has found to be just as harmful to individuals (WHO 2018). It turns out that both smoking and alcohol use increase the number of deaths from non-communicable diseases.

1.2 Aim and research question

The impact of alcohol and smoking on life expectancy and gender gap differences in Central Asia specifically has not yet been studied. The aim of this research is, therefore, to explore and examine the impact of alcohol use and smoking on the gender difference in life expectancy in Central Asia and how this changed over time between 1981 and 2017.

The following sub-questions are stated for more guidance:

1. What is the trend in the life expectancy gender gap in the five Central Asian countries between 1981 and 2017?
2. How much do alcohol use and smoking contribute to the gender gap in life expectancy in the different Central Asian countries?
3. How did the contribution of alcohol use and smoking on the gender difference in life expectancy evolve?

1.3 Academic relevance

Even though much is known about alcohol use and smoking and the effects on diseases and mortality, less is known about the influence of alcohol and smoking on the life expectancy gender gap. Trias-Llimós & Janssen (2018) state that more research on both alcohol- and smoking-related mortality differences in gender life expectancy can contribute to the progress of further reducing mortality. Especially in Central Asia, there is a gap in terms of knowledge about the effects of alcohol and smoking on the gender difference in life expectancy. Over the past decades more research focused on this region, but this aspect remains unclear as literature on this in Central Asia is only sparsely available. Davletov et al. (2016) indicated the need for a more systematic research approach on reasons behind premature death in Kazakhstan and surrounding countries. They already conclude that smoking and hazardous alcohol consumption may contribute to the explanation of gender differences in life expectancy, but no further research has been done so far. Although Myrkassyomava et al (2018), focuses on the contribution of different age groups on the increases in life expectancy in Central Asia and not on the contribution of alcohol- or smoking-related mortality, they come to the same conclusion that there is limited literature on improvements of life expectancy and reasons for mortality patterns. This study will therefore focus on mortality differences in Central Asia to provide a first overview of the contribution of smoking and alcohol use to the gender life expectancy gap.

1.4 Societal relevance

The WHO (2014 & 2018) states that the increase in non-communicable diseases globally can be seen as a crisis and lifestyle-related diseases are more prevalent. Indicating possible causes, like alcohol or smoking and, will lower pressure on health care systems as well as the working-age population. Additionally, with regards to (sustainable) development goals, such as health equity, poverty reduction, human security, and economic stability the increase in non-communicable diseases may impede a successful outcome. Preventing and controlling non-communicable diseases through political commitment and societal investments in lifestyle changes are desired (WHO, 2014). As there is an increase in non-communicable diseases in Central Asia, exploring the effects of alcohol use and smoking will contribute to see to what extent lifestyle behaviour affects health outcomes and life expectancy. Since there already is some indication that this might differ for males and females and a gender gap in life expectancy can be noticed, examining the role of alcohol consumption and smoking will be beneficial to show potential societal gains.

1.5 Outline

The first chapter outlined the background in which this research will be conducted and stated the aim and guiding questions, followed by the academic and societal relevance. Chapter 2 provides the theoretical framework and conceptual model in which this research is embedded and provides a literature review on alcohol and smoking behaviour in relation to health outcomes, life expectancy, and the gender gap in life expectancy. Chapter 3 discusses the methods of analysis and the datasets which will be used, and the fourth chapter presents the empirical results of the analysis. The final chapter will discuss the data, methods, and findings, make recommendations for further research and policymakers, and draw conclusions.

2. Theoretical framework

2.1 Epidemiologic transition theory

The epidemiologic transition theory was introduced by Omran (1971). The epidemiological transitional model describes four stages and a future stage of declining and changing mortality patterns (Omran, 1998 & 2005). Omran saw a change over time in the causes of death of different populations from the prevalence of infectious and communicable diseases towards the prevalence of man-made and degenerative diseases (Mackenbach, 1994). This change was caused by the interaction between mortality patterns and societal development, including economic, social, and demographic determinants and consequences. The theory links to the demographic transition model as the developmental changes in society and modernisation caused this change in mortality patterns. Additionally, five propositions are used within the theory to explain the mortality pattern and relate to the different stages (Santosa et al., 2014).

The first proposition relates to the first two stages of the epidemiologic transitions. It states that mortality patterns play a dominant and important role in population changes (Santosa et al., 2014). The first stage, *the age of pestilence and famine*, is characterised by a low life expectancy at birth varying from 20 to 40 years and fluctuating and high mortality rates, due to the prevalence of communicable and infectious diseases (Omran, 1998). Omran stated that during this stage life expectancy for females is equal to or lower than male life expectancy because of high levels of maternal mortality. Birth rates in this stage are high and because of high death rates, population growth is slow and is therefore reflecting the first stage of the demographic transition model with low living standards and poor sanitation. The second stage, *the age of receding pandemics*, is showing a transition as mortality rates decline and life expectancy at birth increased up 50 years. Life expectancy is similar for men and women and in some societies female life expectancy is higher. More specifically, child mortality decreased as a result of better living standards and improved sanitation. In this stage, there is a decline in the occurrence of epidemics and infectious diseases and at the same time an increase in non-communicable diseases like CVDs, stroke, or various types of cancer (Omran, 2005). Yet, the main contributor to mortality patterns is infectious diseases.

The second and third propositions relate to the third stage of the transition, *the age of degenerative and man-made diseases*. The propositions respectively state that there is a gradual long-term shift from infectious diseases towards the prevalence of degenerative diseases and a decrease in fertility rates as there are lower child and maternal mortality rates (Santosa et al., 2014). In the third stage, non-communicable and degenerative diseases are leading causes of death, life expectancy is increasing, and more man-made diseases are emerging, like stress. (Omran, 2005). From this stage onwards the epidemiologic transition usually favours females over males in terms of life expectancy, especially after the decrease in infectious diseases, pandemics, and improvements of living standards and lifestyle. People started to focus more on lifestyle and the quality of life, including the psychological and emotional factors to create better health outcomes for themselves and their children.

The fourth stage is *the age of declining cardiovascular mortality, ageing, lifestyle modification, emerging and resurgent diseases* and relates to the fourth proposition. This stage is characterised by low birth and death rates and high life expectancy (Omran, 2005). The proposition recognises the link between population changes in health and diseases patterns in the long term as well as social, economic, and demographic factors, and mortality changes (Omran, 1998; Santosa et al., 2014). New innovations in health care systems and drug use, and individually reducing risk factors contributed to a reduction in mortality of CVDs during this stage. The overall living standards improved, and populations are ageing but cancer-related mortality increases gradually, morbidity is rising and there is a revival of infectious and communicable diseases such as HIV, Ebola, or Hepatitis. Moreover, lifestyle is playing a more important role and people start to focus more on increasing positive health outcomes, through physical activity or dietary intake. Although lifestyle adaptation is seen as a positive development and became a more important factor in the fourth stage, there were additional lifestyle changes that had more negative effects and Omran (1998, p.106) refers to this '*risky health habits'*. Omran noticed some gender differences in morbidity and mortality patterns in relation to lifestyle changes. Males for example have higher lung cancer mortality rates, but female lung cancer mortality rates start to increase as a result of an increase in smoking prevalence among women.

The future stage is *the age of aspired quality of life*, with paradoxical longevity and (futuristic stage) persistent inequities (Omran, 2005). This stage is marked by paradoxical longevity in which populations continue to age due to adaptations in a healthy lifestyle and disease control, while at the same time there is more chronic morbidity and health inequality. Infectious diseases only play a minor role in mortality patterns whereas man-made, chronic, and stress-related diseases are now dominant causes for both morbidity and mortality. Diseases and conditions like isolation, depression, and loss of independence due to morbidity are more common. Hence innovations and efforts for medical breakthroughs continue in order to improve the quality of life and lowering morbidity, especially for disadvantaged and vulnerable populations. In addition, policies are implemented to discourage unhealthy lifestyles and risky behaviour such as alcohol consumption or smoking.

The epidemiologic transition model is based on empirical studies in the western and developed world and is a generalisation of the changes in mortality patterns (Santosa et al., 2014). Worldwide there are differences in when countries enter a certain stage or how fast countries transition and some countries do not experience all the stages. This relates to the fifth and final proposition, which states that there are three different pathways to go through the epidemiolocal transition (Santosa et al., 2014). The different identified models are (1) the classical model in which western countries experienced a relatively long transition going through all the stages, (2) the accelerated model, in which countries go through all the stages but experience a rapid transition and (3) the contemporary/delayed model, in which countries experience a slow and delayed transition with a double burden of diseases.

2.2 Determinants of health

The health of an individual or community is affected by a combination of many different factors and is referred to as the determinants of health (Marmot & Wilkinson, 2005; CDC, 2021; WHO, 2021b). According to the WHO the determinants can be categorised into three main groups (1) the social and economic determinants, (2) environmental determinants and the physical environment, and (3) behavioural determinants and individual characteristics. Omran (1971 & 2005) already noticed the interaction between mortality patterns and societal development, and it is important to understand how these patterns emerge and which determinants play a role. Especially social and behavioural determinants are of interest as these are concerned with personal choices, lifestyle, and the social conditions of an individual (Denton & Walters, 1999; WHO 2021b)

Social determinants of health are related to the non-medical factors that impact health outcomes and refer to a group of social factors (WHO, 2021b). The social determinants are circumscribing several dimensions of someone's life and relate to, when and where they are born, how they grow and age, and where they work and live (Marmot & Wilkinson, 2005). It is related to the resources needed to meet daily needs, get social support, interaction, and safety through socio-economic conditions and include, but is not limited to income, education, employment, housing, social protection, social inclusion, literacy skills, and access to and quality of health services (Marmot, 2005; Solar & Irwin, 2010; Viner et al., 2012; CDC, 2021; WHO, 2021b). Many of these determinants are interrelated and influence each other (Solar & Irwin, 2010).

According to the WHO (2021b) social determinants of health can be more important to one's health than health care or even lifestyle choices and can either have a positive or negative impact on health outcomes. Especially among vulnerable groups, for example, children, women, elderly, minorities, or people in lower socioeconomic groups, social determinants contribute to premature diseases and deaths significantly (Marmot, 2005; Whitehead & Dahlgren, 2006; WHO, 2008). The 15 million premature deaths as a result of non-communicable diseases mostly occurred in middle- and low-income countries in 2016 (WHO, 2021b) Moreover, poorer populations with lower incomes and less access to basic amenities or health services are experiencing worse health when comparing them to rich populations (Whitehead & Dahlgren, 2006; WHO, 2021b). On the opposite side, better housing and working conditions, social inclusion, and social protection lead to better health outcomes (Marmot & Wilkinson, 2005; Viner et al., 2012).

The behavioural determinants of health are related to the social determinants of health but focus more on lifestyle choices (Denton & Walters, 1999). They state that whereas social determinants of health are more commonly related to social structure and communities, the behavioural determinants are more related to individuals and personal choices. The behavioural determinants focus on behavioural risk factors and include alcohol consumption, smoking, dietary intake, and physical activity (WHO, 2002; Peel et al., 2005).

Alcohol consumption, smoking, diets, and low physical activity have all been linked to inequalities in health (Marmot; 1994; Denton & Walters, 1999). On a global level, smoking, unhealthy and poor diets, physical inactivity, and alcohol abuse, are estimated by the WHO (2002) to account for over one-third of the chronic disease burden. Lower smoking and alcohol rates and lower rates of under- and overweight within a population have a positive influence on health outcomes (Aida et al., 2018). Withal Khaw et al. (2008) found evidence for a cumulative impact on health outcomes and mortality. On the one hand is risk behaviour such as heavy smoking or alcohol abuse cumulatively impacting health outcomes in a negative way and on the other hand do healthy diets and physical activity have a positive cumulative effect on health outcomes (Khaw et al., 2008). Although the determinants of health, in general, include more than just lifestyle behaviour, as many socio-economic and cultural factors play an important role as well, this study will focus on the behavioural determinants of health, more specifically on alcohol use and smoking.

2.3 The gender gap in life expectancy

As of today, gender differences in life expectancy are occurring and it shows that females have a higher life expectancy compared to males (Waldron, 1983; Meslé 2004; Oksuzyan et al., 2010; Cullen et al., 2016; Goldina & Lleras-Muney, 2019). Waldron (1983) points out that these gender differences are related to behavioural and biological aspects. According to Luy and Wegner-Siegmundt (2013), the biological difference between men and women in western European countries accounts for about 25%. The remaining difference can largely be explained by social-behavioural factors and play a more important role in the difference in male and female life expectancy (Hart, 1989).

From a biological and genetic point of view, there is much evidence for the difference in male and female life expectancy. First, genetic factors are influencing gender differences in human mortality and already occur when comparing male and female foetal or child morality (Waldron, 1983). Inherent genetic factors have apparent advantages for females at all ages, however, in some societies infant mortality is higher among females due to infectious diseases and environmental factors. An additional biological factor that increases the risks of premature female mortality is the fact that women are able to give birth (Waldron, 1983). Nonetheless, maternal mortality does heavily depend on how advanced health care systems are (Ronsmans, 2006). A second reason for higher female life expectancy is the distribution of chromosomes (Seifarth et al., 2012; Goldina & Lleras-Muney, 2019). Men are born with one X and one Y (XY) chromosome and women are born with two X (XX) chromosomes and when understanding the difference, it explains some of the gender gap in life expectancy (Goldina & Lleras-Muney, 2019). For males, having XY chromosomes leads to no protection against disadvantageous genes on the X chromosome, so if the one X chromosome carries potential unfavourable genes this will be expressed in all of the cells of the male body. The second female X chromosome protects females against this, and the unfavourable gene will only exist in half of the cells of the female body (Seifarth et al., 2012). Thirdly, hormones influence the difference in male and female life expectancy as men have androgen (including testosterone) and women have oestrogen (Seifarth et al., 2012; Regan & Patridge, 2013; Goldina & Lleras-Muney, 2019). Due to the prevalence of oestrogen, female advantages occur in immune functions, antioxidant status, and stress response. Besides, it leads to some extent to more protection against CVDs (Seifarth et al., 2012; Regan & Patridge, 2013). At older ages however a relatively fast decrease in oestrogen levels in the female body, compared to a more gradual decrease in testosterone in the male body, causes a reduction in female mineral bone density and increases the risk of CVDs (Seifarth et al., 2012; Regan & Patridge, 2013). Although Seifarth and colleagues try to theorise that the relative difference in hormones causes females to live longer, Gooren et al., (2008) contradicts this. They stated that supplementation of androgen or oestrogen causes neither an advantage nor a disadvantage in morbidity or mortality when studying transgender people.

Aside from genetic factors, behaviour factors play a role in gender differences in mortality patterns and life expectancy (Oksuzyan et al., 2008; Hossin 2021). Behavioural differences between men and women have more influence on gender differences than the biological factors and mostly lead to male disadvantages (Hart, 1989; Luy and Wegner-Siegmundt; 2013). More specifically, early risk behaviour among young male adolescents compared to young females is the main reason for the difference (Rogers et al., 2010). This earlier adopted risk behaviour among men expresses itself in a male mortality hump between the age of 10 and 34 (Goldstein, 2011; Remund et al., 2018). The risk behaviour is related to the so-called masculine behaviour and includes smoking, alcohol abuse, substance use or extreme sports (Waldron 2007; Oksyzyan et al., 2008; Rogers et al., 2010; Goldstein, 2011; Clark & Peck, 2012). Besides the masculine behaviour, men are more affected and exposed to risks as a result of doing heavy physical labour, occupational and behavioural hazards. In the end, men die more often from war, (car) crashes, work-related incidents, or sporting activities than women (Short et al., 2013).

There are several explanations why men show earlier or more risk behaviour compared to women. On the one hand, Byrnes and colleagues (1999) state that men seek more sensation or consider themselves as 'more risky' than others, known as the 'risks as value' hypothesis. On the other hand, does the cultural context play a role in such a way that it restricts women more from showing certain risks behaviour. Yet the changing position of women in society led to a change. The difference in showing risks between men and women started to narrow as women start to adopt more risk behaviour as a result of for example an increase in labour force, a growing income, or changing traditional gender roles (Byrnes et al., 1999; Waldron et al., 2005).

2.4 Literature review

2.4.1 The gender gap in life expectancy and lifestyle behaviour

Many studies focused on the difference between males and females and life expectancy (i.e., Wingard, 1984; Nathanson, 1975; Case & Paxson, 2005; Jagger et al., 2008; Crimmins et al., 2010; Oksuzyan et al., 2010). Within their research, they conclude that men live shorter compared to women and in some countries at all ages, male death rates are higher than those of females. This gender gap in life expectancy has been visible since the early 1900s in developed countries when the gap widened, and stagnated a little after the 1970s, but is continuing (Nathanson, 1975; Oksuzyan et al., 2010). In addition to this, male and female differences in life expectancy are visible across the world and within individual states. Rochelle et al., (2015) studied the gender life expectancy gap in 54 countries. Their study showed that around the globe women outlive men, but the gap differs in different countries. This is in line with what many other studies found which are more focused on regions or individual nation-states (Pinkhasov et al., 2010; Clark & Peck, 2012; Rochelle et al., 2015). The outcomes of the different analyses show that the middle-income countries have the highest gap (for example, in Kyrgyzstan it is 8 years) and lower-income countries have the lowest gaps. There is a considerable variation across space and time in the gender gap in life expectancy, and it is not fully understood which behavioural factors are substantially more contributing to the explanation of the gender gap (Oksuzyan et al., 2010, Clark & Peck, 2012).

Even though the contribution of behavioural factors might not be fully understood, different studies conclude that alcohol consumption is an important contributor to differences in gender mortality patterns (Denton & Walters, 1999; Rochelle et al., 2015; Aboulgha et al., 2016; Trias-Llimós & Janssen, 2018). In general alcohol consumption causes additional health risks, for example when extremely high levels of alcohol are consumed the risks of CVDs on an individual level increase, or alcohol abuse can be related to accidental or deliberate alcohol poisoning and alcohol-related incidents (Cockerham et al., 2004; Aringazina et al., 2018). Rochelle et al., (2015) performed an analysis on 54 countries and found a positive correlation between alcohol consumption and gender differences in life expectancy. In the countries with more alcohol consumption, there was a wider gender mortality gap and women lived relatively longer compared to men. In eight Central and Eastern Europe contribution of alcohol to the gender life expectancy gap in 2012 was calculated to be at least 15 percent (Trias-Llimós & Janssen, 2018). A possible explanation they found is that men are more hazardous drinkers and drinking alcohol is more common among men.

Next to alcohol use, smoking is a contributor to the gender gap in life expectancy and mortality patterns (Waldron, 1986; Preston et al., 2011; Janssen, 2020; Janssen et al., 2020). Smoking is identified as the single biggest factor for explaining the gender gap in life expectancy, especially in western countries. It is an important factor that contributes to a rise in CVDs, cancers, and hypertension. In 1986, Waldron calculated the contribution of smoking to gender differences in mortality and found that among adults approximately half of the gender difference in mortality could be ascribed to smoking. This number explained nearly two-thirds of gender mortality difference at younger ages and a quarter among age 80 and over. From a global perspective, it turned out that between 1980 and 2010 male life expectancy could have increased by 2.4 years and female life expectancy by 1 year if smoking-related mortality would be removed (Rentería et al., 2016). This also indicates that patterns in smoking affect the difference in the gender gap in life expectancy. A more recent study in Europe showed that between 1950 and 2014 the gender difference in smoking-related mortality was large, especially when smoking-related mortality was still low among women but high among men (Janssen, 2020a). According to this study, in 2014 the smoking-related mortality accounted for 43.5% of the 7-year gender gap. Nonetheless, there is some critique on the conclusions of the contribution of smoking to the gender gap in life expectancy. Luy and Wegner-Siegmundt (2015) indicate that smoking indeed does play an important role in the gender gap in life expectancy, but over generalising statements that smoking is the main factor is deceptive. They state that decreasing the effect of smoking will indeed lead to a smaller gender gap in life expectancy, but they mention that this gap can be narrowed in different ways.

2.4.2 Life expectancy and life expectancy gender gap in Central Asia

Although literature is sparse, it does indicate a difference in male and female mortality in Central Asia when the five countries were still part of the USSR. In Central Asia during the 1950s and 1960s, male mortality was already higher compared to female mortality (Anderson & Silver, 1986). In other former USSR regions, such as Eastern Europe, the difference between male and female mortality worsened, but it remained somewhat stable in Central Asia. When the gender gap in life expectancy in Central Asia widened, Anderson and Silver (1986) found that this is due to an increase in male mortality from all causes of death. They stated that: '*whatever causes led to an increase in men's mortality did not apply to women'* (p.202). From the 1960s, there is a bit of a gap in research on life expectancy in Central Asia to the 1980s. Mortality at older ages, which can be considered avoidable, rose in the period between 1980 to 1989 (Mathers et al., 2015). Most of these avoidable deaths can be ascribed to CVD and increased from 31 to 38 deaths per 1000 males and 16 to 22 deaths per 1000 females. Additionally, their results show that CVDs and chronic respiratory diseases accounted for a lower life expectancy of one year for men and nearly two years for women.

During the 1990s, this trend of higher male mortality compared to female mortality continued (Falkingham, 1999; Cashin et al., 2002; Cockerham et al., 2004). The differences were estimated for Kazakhstan and Uzbekistan, which for Kazakhstan meant a gender gap in life expectancy of 9.0 years in 1990 and 11.6 years in 1998 and in Uzbekistan, this gap was narrower 6.6 years in 1990 and 5.1 in 1998 (Cashin et al., 2002). Falkingham (1999) and Cockerham et al. (2004) found similar differences. Furthermore, these three studies came to overlapping results and conclusions that life expectancy decreased in the mid-1990s in all the Central Asian countries. The decrease was greater for men than women and greater for fast transitioning countries, which are Kazakhstan and Kyrgyzstan. Based on the numbers presented in the papers by Falkingham and Cockerham and colleagues this decrease in life expectancy was on average nearly 3 years depending on age and gender. Because Tajikistan was affected by an armed conflict in this period it is an exception, since the conflict negatively impacted life expectancy even more (Falkingham, 1999).

Research by Myrkassyomava et al. (2018) showed an increase in life expectancy again in Central Asia after the year 2000. By using WHO mortality data and age-cause decomposition of differences in life expectancy they found that, except for Turkmenistan, lower child mortality resulted in higher life expectancy. A second contributor they found was a decrease CVDs, in particular ischaemic heart disease, which especially in Kazakhstan and to a smaller extent in Turkmenistan led to an increase in life expectancy between 2005 and 2012. Although life expectancy increased, the difference between men and women remained which in Kazakhstan was calculated to be 9.8 years (Davletov, 2015).

2.4.3 Alcohol use and smoking in Central Asia

Since the Central Asian countries were part of the former USSR, not much is known about alcohol consumption in this region during that period. Most studies focus on the effects and consequences of alcohol consumption of Russians, especially of Russian men (Wasserman et al., 1994; Wasserman et al., 1998; Hinote & Webber, 2012). It seems that alcohol consumption and alcohol abuse are more related to the Russian culture compared to other sub-cultures and more related to masculinity. During this period, it led to more alcohol abuse, poisoning, and suicides among men. The consumption of alcohol between 1990 and 2000 differs between the countries and in Kazakhstan and Kyrgyzstan, the total alcohol consumption decreases with respectively four and three liters per capita (WHO, 2021c). In Tajikistan, Turkmenistan and Uzbekistan alcohol consumption remains at a more stable level.

More is known about alcohol consumption in Central Asia after the fall of the USSR. The global status report on alcohol and health by the WHO (2019) shows the development of alcohol consumption in this region after 1990 and some studies focused on this relation between alcohol use and health outcomes. When looking at the development of the different countries, there are some similarities and differences. The WHO report shows that there is an increase in alcohol consumption around the year 2000 in four countries with an increase in the consumption of wine, vodka, and spirits. For Tajikistan, the level remained low, in particular in rural areas where only 12% of males and 0.1% of females consumed alcohol (Smith & Nguyen, 2013). In Kazakhstan, Turkmenistan, and Uzbekistan the levels decreased again around 2010, due to policies and regulations (WHO, 2019).

Besides, from 2000 more is known about gender differences in alcohol consumption and men drink more alcohol compared to women (Figure 1). Levels differ between the counties showing a large difference between men and women in Kyrgyzstan and a smaller difference in Tajikistan. Although there was first a slight increase the gender difference in the consumed amount of alcohol decreased in Kazakhstan and Kyrgyzstan. Tajikistan and Turkmenistan on the other hand show a small increase in the amount of alcohol men drink more compared to women. The difference in Uzbekistan only decreased, but faster between 2000-2010 and slower between 2010-2018. Cockerham et al., (2004) noted the alcohol consumption gap and the related rise in male mortality in former USSR nations. Aringazina et al., (2018). Davletov (2015) concluded that it is plausible that levels of alcohol consumption are reflected in gender and regional differences in life expectancy, as well as the trends over time. When considering the aforementioned difference in alcohol consumption between men and women, this could be a reason for a life expectancy gender gap in Central Asia.

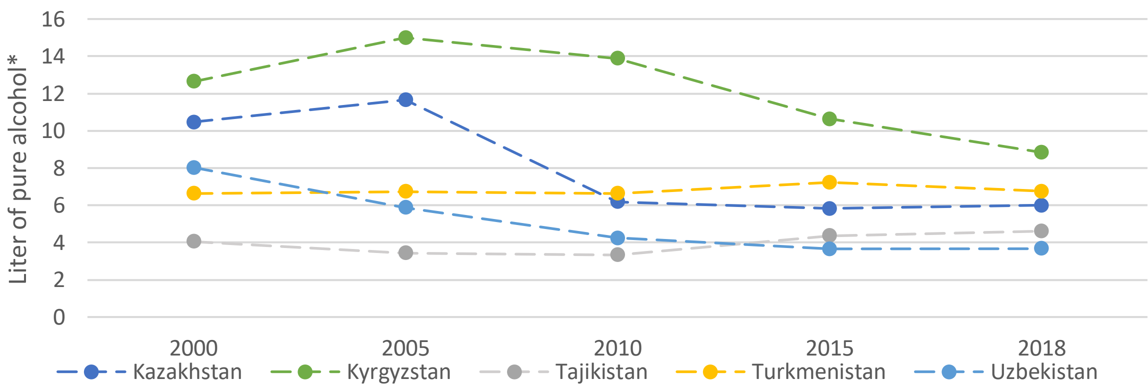


Figure 1: Total liters of alcohol per capita men drink more than women between 2000 and 2018.
**Recorded and unrecorded. Source: WHO (2019)*

Just as for alcohol use not much is known about smoking patterns when the countries were still part of the USSR. What is known is that cigarettes were cheap and easily available, and especially among men smoking during leisure time activities became to norm (Roberts et al., 2012). They also found that between 2001 and 2010 there is a correlation with alcohol use; the more alcohol males consumed the more they smoked. After the USSR period, the international market of cigarettes jumped in, causing an increase in smoking among women. Trends in smoking are reflected in rates of the occurrence of CVDs, lung cancer, and circulatory diseases in Central Asia (Gilmore et al., 2004; Roberts et al., 2012).

Gender differences in smoking are more prevalent than alcohol use. Among men and women, differences occur due to social patterns and education (Sreeramareddy & Pradhan, 2015). For Kyrgyzstan, Tichenor and Sridhar (2019) found that within the population of 15 years and older 50.5% of all men smoked, whereas for women this is only 3.7%. This difference is smaller in other Central Asian countries. In Kazakhstan smoking, is slowly decreasing, but still four times more men smoke compared to women, and for Uzbekistan 26.8% of men and 1.4% of women above age 15 smoke (Aringazina et al., 2018). When looking at gender differences in smoking prevalence in Central Asia the

IHME (2021a) estimated smoking prevalence for men and women (Figure 2). The prevalence of smoking among men is between 10 and 40 percentage points higher than among women in all five countries. Over time it becomes clear that in Tajikistan and Turkmenistan the difference in male and female smoking prevalence becomes smaller and remains at a stable level after 2000. The trends and differences in prevalence in Kazakhstan and Kyrgyzstan fluctuate more and the differences remain much bigger, exceeding 30 percentage points. In Uzbekistan, the difference in smoking prevalence is the lowest among and shows an increase until around 2000 and decreases afterwards as a result of an increase in smoking prevalence among women and a decrease among men.

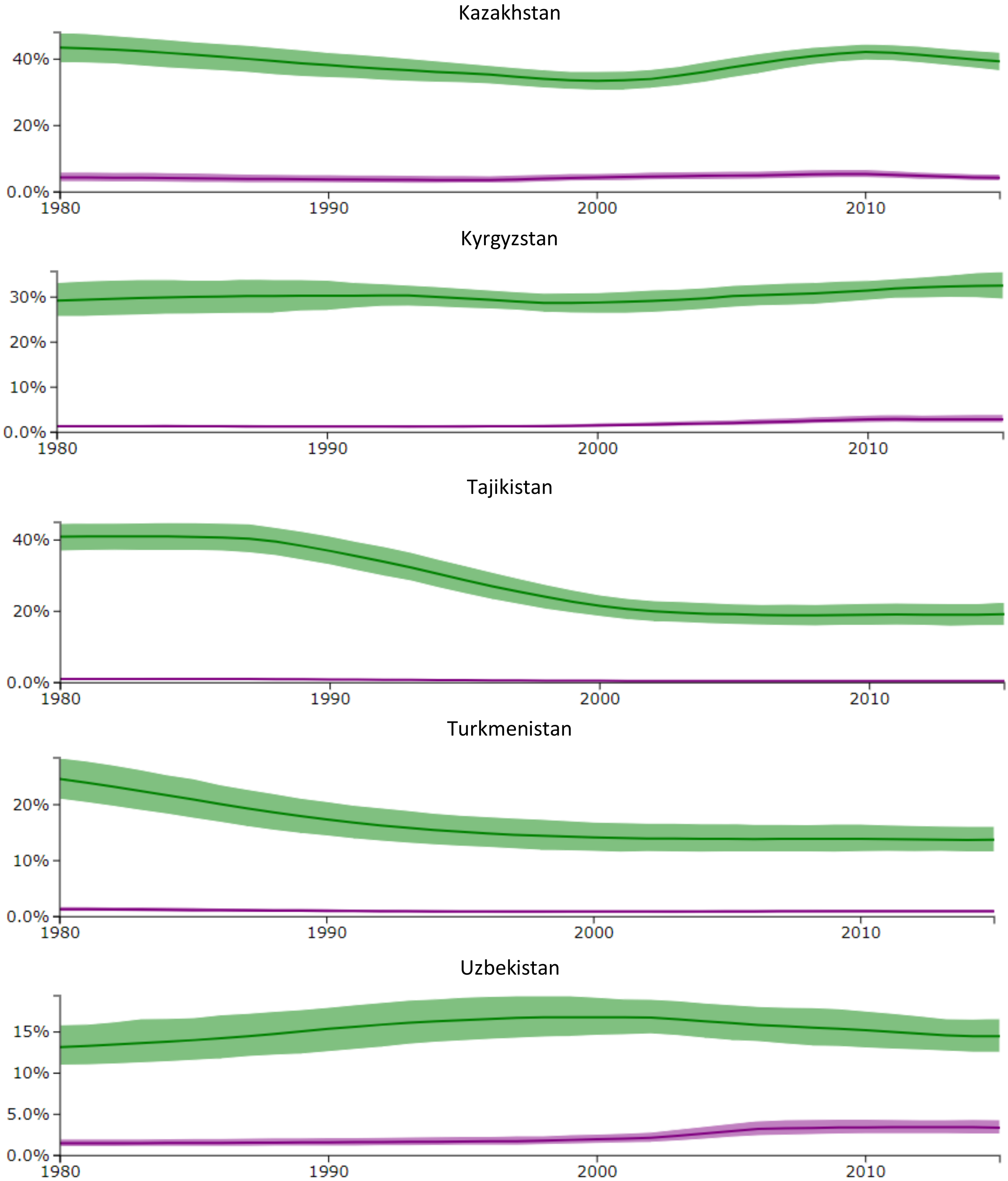


Figure 2: Gender differences in the prevalence of smoking in Central Asia between 1980 and 2015 with confidence intervals. Source: IHME, 2021a.

2.5 Conceptual model and hypotheses

This study focuses on the contribution of alcohol consumption and smoking to the gender gap in life expectancy in Central Asia and Figure 3 represents the conceptual model with the three main theories that form the basis of this study. The starting point is the determinants of health which can be divided into behavioural, socio-economic, and environmental determinants and influence health outcomes of individuals or populations (Denton & Walters, 1999; Marmot & Wilkinson, 2005). Behavioural determinants are particularly interesting as these include alcohol use and smoking and affect mortality levels of populations. Within populations, men and women do not show the same behaviour with regards to alcohol use and smoking, leading to gender differences in mortality patterns (Waldron, 1983; Hart, 1989; Oksuzyan et al., 2010). As a result of different mortality patterns, a gender gap in life expectancy will occur, which can thus be explained through gender differences in alcohol use and smoking. Over time the gender gap in life expectancy may differ as well as the contribution of behavioural gender differences in alcohol use or smoking, which relates to Omran's (1971, 2005) epidemiologic transition theory. Especially in the later stages of the epidemiologic transition lifestyle started to play a role in health outcomes and if reflected mortality patterns.

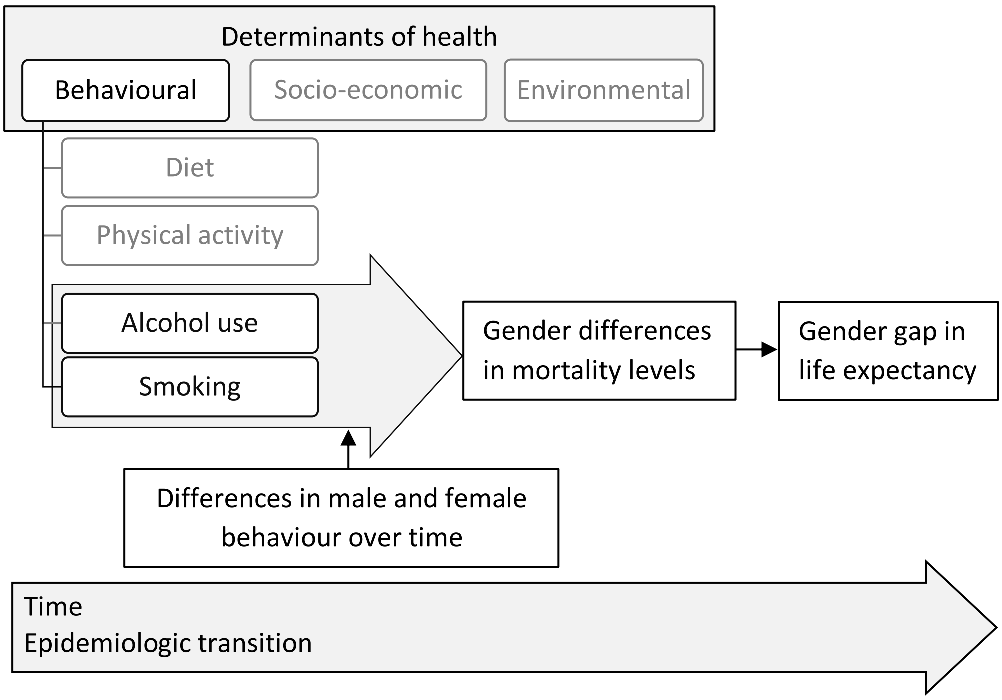


Figure 3: Conceptual model

Several hypotheses are derived from the conceptual model and literature review. First, it is expected to find higher life expectancy among women throughout the 1981-2017 period as inherited genetic factors and lifestyle behaviour have apparent advantages for females. With regards to former USSR republics, it is likely that the gender gap in life expectancy in Central Asia will increase up until 1990-2000 and decrease afterwards. Second, lifestyle factors can partly explain the gender gap in life expectancy. As a result of this, it becomes clear that in Central Asia, on average, males consume more alcohol and smoke more compared to females, leading to a lower life expectancy among men. Especially in Kazakhstan and Kyrgyzstan, it is expected to find higher contributions of alcohol use and smoking compared to Tajikistan, Turkmenistan, and Uzbekistan, as the differences between male and female drinking and smoking patterns are much bigger in Kazakhstan and Kyrgyzstan. Thirdly, how the impact of alcohol use and smoking evolved between the period 1981-2017 and the contribution of this to the gender gap in life expectancy depends on the trends of alcohol use and smoking, and differs per country:

- For Kazakhstan, it is expected to find an increase in the contribution of alcohol use until 2005 and a decrease after that. The contribution of smoking is expected to subsequently slowly decrease until 2000, increase until 2010, and decrease again after 2010.
- For Kyrgyzstan, the contribution of alcohol use is expected to increase until 2005 and decrease after 2005. For smoking, it is expected that the contribution will stay at a more or less similar level through the period 1981-2017.
- For Tajikistan, the contribution of alcohol is expected to show a minor increase after 2000. For smoking, it is expected to find a decrease in the contribution between 1985 and 2000 and a levelled contribution after 2000.
- For Turkmenistan, it is expected to find a minor increase in the contribution of alcohol after 2000. For smoking, the contribution is expected to decrease until around 2000 and remains levelled afterwards.
- For Uzbekistan, the contribution of alcohol is expected to decrease until around 2010 and remains levelled afterwards. The contribution of smoking is expected to show an increase until 2005 and a decrease afterwards.

3. Methodology

3.1 Research design and setting

This research consists of a quantitative analysis using secondary aggregated data over time. The analysis will be performed on yearly data about the five Central Asian countries from WHO mortality Database and the Global Burden of Disease study. This research will focus on the contribution of alcohol use and smoking on the gender gap in life expectancy in Central Asia and can be considered descriptive as it aims to explore and examine the impact of alcohol use and smoking on the gender difference in life expectancy in Central Asia and how this is changing over time. This will be done by generating life expectancy and through estimation of alcohol- and smoking-related mortality. The geographical area which this research will focus on is Central Asia and is defined by the UN and the World Bank as Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan. The analysis will be performed at the country level, as spatial differences within countries are not of relevance to reach the aim of identifying the contribution of alcohol use and smoking to the gender gap in life expectancy. Besides, the time frame for this research will be the period between 1981 and 2017. The reason for this is that for this period there is data available for most of the years and/or countries (appendix 1).

3.2 Data sources

3.2.1 WHO mortality database

Cause-specific mortality data and population data will be retrieved from the WHO all-cause mortality dataset (WHO, 2021d). It is a recent open-source harmonised dataset with long-term and reconstructed trends of populations and cause-specific mortality. The population data is split up between year and sex and will be used to calculate life tables. It will be possible to constructs the trends in life expectancy in the set period for single calendar years. Moreover, it is possible to see the differences in life expectancy between males and females and identifying the gender gap. Additionally, it includes the ICD-9 (International Classification of Diseases) and ICD-10 and gives a mortality profile per country, year, age, sex, and cause of death from 1980 to 2019. Registrations of national vital statistics are comprised in the dataset with coded causes of death. The data is based on data from the different countries themselves and considered high quality. Because of classification within the ICD, causes of death are more likely to be objective regardless of the country which reports the death. By using the same classification system, the data on causes of death in the different countries is comparable.

When analysing demographic data cautiousness to possible inconsistencies and limitations is needed (Preston, 2001). There are some issues and limitations with WHO dataset and the main limitation is the missing population and mortality data (appendix 1). There is no data available for 1983 and 1984 for all countries, and there are some country-specific yearly gaps. The main concern is the missing data on Tajikistan for the period between 2006 and 2016, for these ten years there is no data available on cause-specific mortality which makes it impossible to identify the impact on gender differences in life expectancy. Therefore, it is decided to only include the years of which there is data available in this part of the analysis, on the estimation of alcohol- and smoking-related mortality and decomposition of the gender gap in life expectancy.

3.2.2 Global Burden of Disease

The Global Burden of Disease Study (GBD) from the Institute for Health Metrics and Evaluation (IHME) contains information on more than 300 types of causes of death for a period between 1990 and 2019. The GBD uses data from multiple data sets of the different countries and includes censuses, death and disease registrations, scientific literature, and surveys to increase accuracy (IHME, 2018). The GBD provides a risk factor attribution from which estimations can be made on how much of a cause of death can be ascribed to a risk factor. With this, it is possible to determine which proportion of deaths is related to behavioural factors like alcohol use or smoking. When considering the GBD factions, differences can be made between individuals who died of for example ischemic heart disease because of alcohol abuse and those who died of ischemic heart disease but did not drink alcohol. A limitation of this dataset is that no information is available from before 1990. Hence, a comparison was made between the risk factors over time and only small differences occurred, so the fraction for 1981-1989 will be the same as the one for 1990.

3.2.3 Ethical considerations

The GBD provides the data on aggregate populations on a yearly basis and the WHO has been updating their mortality dataset a few times over the past 15 years. In both cases, the most recent versions of the datasets will be used. The two datasets handle the data in such a way that no personal information can be found. In addition, no individual can be traced within these datasets.

3.3 Methods

3.3.1 Life tables and life expectancy

Life tables provide insights in the mortality patterns of populations and are often used as a tool in demographic studies. The outcome measures of a life table include age-specific death rates, probability of surviving or dying in an age group, and the remaining life expectancy at age *x* (Preston et al., 2001). Life tables are used to summarise mortality patterns of an observed or hypothetical cohort. It is an effective method for comparing populations, as life tables standardise differences in size and age composition of different populations. In the case of this research males and females are considered different populations and with regards to the timeframe the female population of for example 1985 is not the same as the female population of 2005. Therefore, life tables are a convenient method to apply to compare population groups as no two groups have an exactly equal composition or size.

Since a part of the population that will be analysed is still alive a period life table will be used. The information in a period life table shows '*what would happen to a cohort if it were subjected for all of its life to the mortality conditions of that period*' (Preston et al., 2001, p. 42). It is a model of a hypothetical cohort based on mortality conditions over a life period. The fact that the life table now turns into a model aims that it does not consider future improvements in health conditions, health care, or innovation and cannot reflect the reality of cohorts. Yet it does provide an overview of mortality patterns of one or more populations.

The main outcome of a life table, that is important for this analysis, is life expectancy at birth, and equals the average age at death of a cohort (Preston et al., 2001). Preston et al., (2001, p. 39) defined life expectancy as '*the average number of additional years that a survivor to age x will live beyond that age'*. With this, the mortality conditions of populations can be understood and summarized from birth onwards. Life expectancy (at birth) provides a measurement for the average health of a population as it shows the average age at death for one or multiple cohorts (Anthamatten & Hazen, 2011).

The data which will be used for the gender gap in life expectancy is obtained from the WHO Mortality Database. By calculating life tables and life expectancy for males and females separately, the gender gap in life expectancy can be identified for each year. This will be done by subtracting the estimated life expectancy of males from the estimated life expectancy of females for all five Central Asian countries in the set time frame. In the life table, the data will be split up in different age groups. For this analysis, 5-year age intervals will be used except for the first age group and uses the following format: 0, 1-4, 5-9, 10-14, … 90-94, 95+. An age group that requires attention is the last open-ended interval of 95+. Theoretically, this age group lasts to infinity, however everyone will die at some point in time and the probability of dying during this interval will be set to 1. By doing so the number left alive at the beginning of the interval (l_x) is the same as the number of those who are dying in the interval (d_x), which means person-years lived in the age interval (L_x) will be calculated by dividing l_x over the death rate (m_x) to close the life table (Preston et al., 2001).

3.3.2 Estimation of alcohol- and smoking-related mortality

To estimate the mortality rates, this research will distinguish four groups; (1) mortality related to alcohol use, (2) mortality not related to alcohol use, (3) mortality related to smoking, and (4) mortality not related to smoking. Estimation of lifestyle-related mortality can be accomplished by using risk factors attributions. On the one hand, some of the alcohol-related and smoking-related causes of death can be fully ascribed to lifestyle behaviour, like alcohol liver disease, alcohol poisoning, or laryngeal cancer for alcohol use. Whereas on the other hand, some causes of death can only partly be ascribed to alcohol use, like ischaemic heart disease, and additionally not all lung cancer is related to smoking (Peto, 1996, Rehm & Imtiaz, 2016; Trias-Llimós & Janssen, 2018; Janssen, 2020a). Although risk factors are used to determine the proportion of deaths that is related to either alcohol use or smoking, different methods will be used for both fractions.

Alcohol

To estimate alcohol-related mortality an attributable fraction approach will be used and applied in a similar way as Trias-Llimós and Janssen (2018) did in their study on alcohol use and the gender gap in life expectancy in eight Central and Eastern European countries. Trias-Llimós and colleagues (2018) compared eight different approaches, five of these used a cause-of-death approach, and three of these used an attributable fraction approach. They concluded that although the attributable fraction approaches heavily depend on data quality and availability, these approaches: '*are theoretically able to provide more accurate estimates of alcohol-attributable mortality'* (p.9). Different studies that look at alcohol-related mortality, apply the attributable fractions approach using the estimates of the GBD (i.e., Neufeld, & Rehm, 2013; Trias-Llimós & Janssen, 2018).

To estimate alcohol-attributable mortality, alcohol-related causes of death have to be selected. The selection of causes of death of Trias-Llimós and Janssen (2018) that they distinguished from a paper by Rehm and Imtiaz (2016) will be the starting point. To initially be able to compare the different countries, adjustments to their table were made due to limitations in the different coding lists of the WHO dataset (Table 1; see appendix 2). This especially concerns the aggregation of mortality fully attributable to alcohol use with other causes of death. As a consequence of the code aggregation, all causes of death can now only be partly attributable to alcohol use. For example, within the WHO data not all classification lists distinguish *Mental and behavioural disorder due to alcohol use*. In order to make the lists comparable, the aggregated cause of death *Mental and behavioural disorder due to substance* will be used, which includes more than just alcohol. For partly alcohol-attributable mortality, age-specific mortality rates of the WHO mortality database for causes of death partly attributable to alcohol will then be multiplied by the cause-specific alcohol-attributable fractions from the GBD. This will be done for each country, year, gender, and age group to obtain the number of deaths attributable to alcohol use. The next step is to sum up country-, year-, and gender-specific deaths to obtain age-specific alcohol-attributable mortality.

	Cause of death	ICD-10 code
Partly attributable to alcohol	Mental and behavioural disorders due to substance use	F10-F19
	Liver diseases	K70-K76
	Ischemic heath disease	I20-I25
	Cerebrovascular disease	I60-I69
	Transport accidents	V01-V99
	Colon and rectum cancer	C18-C21
	Oesophageal cancer	C15
	Larynx cancer	C32
	Lip and oral cavity cancer	C00-C14
	Tuberculosis	A12-A19
	External causes	W00-Y98
Not attributable to alcohol	All other causes	All other codes

Table 1: Selected causes of death and ICD-10 codes partly attributable to alcohol use and not attributable to alcohol use. Source: based on Trias-Llimós & Janssen, 2018

Smoking

To estimate mortality attributable to smoking serval different steps have to be taken, which will be the same as Janssen applied in studies on the contribution of smoking to the gender gap in life expectancy (i.e., Janssen 2020a & 2020b). Lung cancer data from the WHO Mortality database will be used as a proxy for the prevalence of lifetime smoking as almost all lung cancer is a result of smoking (Janssen, 2020a, 2020b). Moreover, to take into account the effect of smoking on causes of death other than lung cancer, relative risks will be used to calculate smoking-attributable fractions based on the Peto-Lopez method (Peto et al., 1992 & Janssen, 2020a).

Lung cancer mortality rates for males and females for different age groups are obtained from the WHO mortality database for the different years and different countries. The prevalence for each year will be calculated by dividing age- and gender-specific lung cancer rates by the total population. To estimate the prevalence of lifetime smoking these age- and gender-specific mortality rates will be compared with age- and gender-specific lung cancer rates of smokers and non-smokers of the CPS-II study of the American Cancer Society (Janssen, 2020a). To do so, the Loess smoothing method will be applied before making the comparison to determine the function of the data (Janssen, 2020a). This prevalence is needed to apply the Peto-Lopez method (Janssen, 2020b). An indirect and simplified version will be used which uses all causes of death combined for each year and age instead of year and age by cause of death. It takes into account that not all deaths from lung cancer are attributable to smoking and additionally, includes deaths related to smoking from other causes of death (Janssen, 2020b). Lastly, the smoking-attributable mortality fraction (SAMF) will be calculated using the following formula: $SAMF_{xs} = p_{xs}(RR_{xs}-1)/(p_{xs}(RR_{xs}-1)+1)$. In which x and s represent year and gender, respectively. p is the prevalence of smoking and RR is the relative risk of dying from smoking. Negative results will be set to zero and results larger than one will be set to one (Janssen & Van Poppel, 2015). For each 5-year age group above the age of 35, relative risk will be calculated by dividing the all-cause mortality rates among ACS CPS-II current smokers by the all-cause mortality rates among ACS CPS-II never smokers for men and women (Thun et al., 1997; Janssen 2020a). The excess risk will be reduced by 30% to control for the exposure of men and women who smoke to other risk factors (Ezzati & Lopez, 2003).

3.3.3 Decomposition of the gender gap in life expectancy

To see to what extent the gender difference in life expectancy is a result of alcohol use and smoking, a standard decomposition technique can be applied. Decomposition techniques are used to study changes in life expectancy at birth and how much an age group contributes to the total gap in life expectancy (Preston et al, 2001). Using a decomposition technique instead of a life table for non-alcohol and non-smoking-related mortality has the advantage that no hypothetical assumptions have to be made about the complete removal of alcohol- or smoking-related mortality (Janssen, 2020a). Hence alcohol-related mortality, smoking-related mortality, and mortality not related to alcohol or smoking can be analysed simultaneously.

Discrete decomposition approaches are described by Andreev (1982, 2002), Arriaga (1984), and Pressat (1985). Although there are differences in how the formula of Arriaga is written down, the formulas are essentially equivalent to each other (Andreev, 2002; Horiuchi et al., 2008). The steps which are taken for each country and each year are used by Janssen and Van Poppel (2015) and based on the method described by Arriaga (1981). The formula will be applied to the 5-year age groups for alcohol-related, smoking-related, and non-alcohol and non-smoking-related mortality for the different Central Asian countries and for each year. First, gender differences in life expectancy will be decomposed for the 5-year age groups to estimate the contribution of the age groups to the gender gap in life expectancy. Second, decomposing the contributions of the specific 5-year age groups into the contributions of alcohol-related and smoking-related mortality rates will be done by multiplying the calculated estimations of alcohol-related and smoking-related mortality rates (explained in 3.3.2), with the estimated contribution of the age groups from the first step. The remaining difference is thus not related to alcohol use and smoking. Third, summing up alcohol-related, smoking-related, and non-alcohol or non-smoking-related mortality rates of the age-specific contributions of all age groups for the different years. By applying this method, the absolute (in years) and relative (in %) contribution to the gender gap in life expectancy becomes clear. This will be done for each country with the latest available data which for Kazakhstan is 2017, for Kyrgyzstan, Tajikistan, and Uzbekistan is 2016 and for Turkmenistan is 2015.

The method to decompose the gender gap in life expectancy will be applied to all years between 1981 and 2017, for the available year, to see the contribution of alcohol use and smoking to the gender gap in life expectancy over time. By doing so, it is possible to determine in which year the impact of alcohol or smoking on the gender gap in life expectancy was the least or the most.

4. Results

4.1 The gender gap in life expectancy in Central Asia

Within Central Asia, gender differences in life expectancy at birth occur in all five countries (Figure 4). Based on the WHO data, how much the difference is, and how this difference evolved between 1981 and 2017 is different for each country. For Kazakhstan, the difference is the greatest in 1998, and between 1981 and 2017 women lived on average 10.1-year longer than men. After 1981, the gender gap in life expectancy was slowly narrowing but increased and remained high between 1989 and 2009. During this period, the difference was the greatest and reached 11.44 years in 2000. After 2009 the gap narrowed again to 8.03 years in 2017. In Kyrgyzstan, the gender difference in life expectancy between 1981 and 2017 remained more stable than the other countries with on average a gap of 8.1 years. The greatest difference was in 1981, 8.94 years, and the lowest difference in 2017, 6.95 years. Tajikistan has the smallest gender gap in life expectancy in the region, with the exception of 1993-1996, with an average of 4.7 years. A major increase in the gap is visible between 1987 and 1998 in which reaches its peak in 1993 with a difference of 5.85 years. In 2016, the difference is 3.81 and is around the same level as in the early 2000s. In Turkmenistan, the gender gap in life expectancy fluctuates until the late 1990s. After reaching the smallest in 1994 4.89 years, the gap increases a little and remains quite stable for the remaining period. Lastly in Uzbekistan, there is a slow and to some extent stable decrease in the gender gap in life expectancy after 1990. Since then, the gap is closing slowly from almost 7 years to where it is now at 5.4 years.

Although the Central Asian countries show differences in the gender gap in life expectancy in terms of the number of years, there are also some similarities visible within the WHO data. Up until the late 1980s, the gap is narrowing and subsequently increases and decreases again. Still, the difference between male and female life expectancy is lower in 2017 than in 1981, and female life expectancy remains higher than male life expectancy for all five countries for all years between 1981 and 2017.

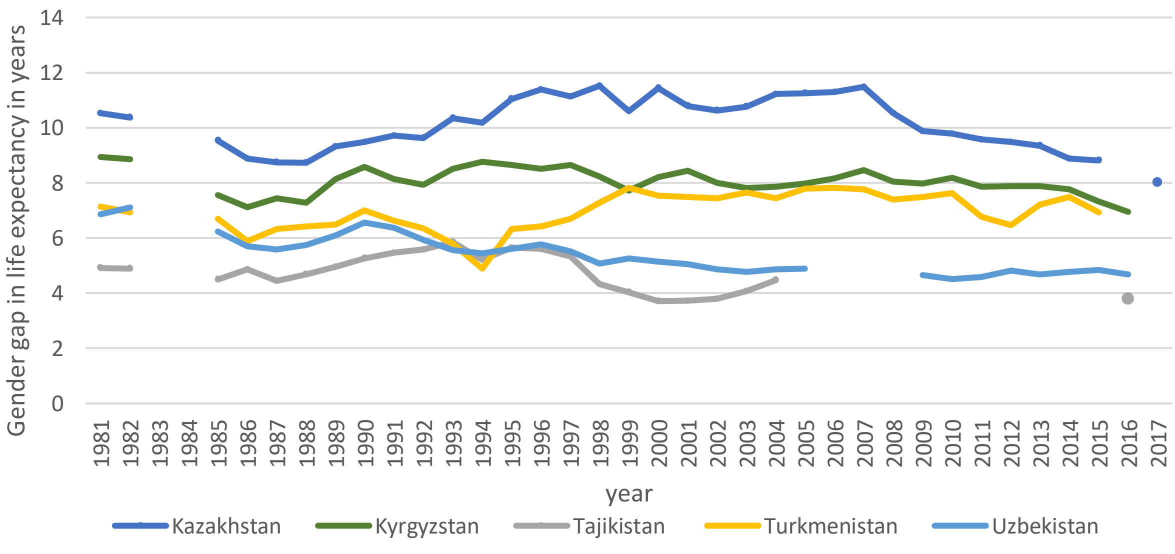


Figure 4: The gender gap in life expectancy in Central Asia between 1981 and 2017 (women-men). Source data: WHO (2021d), Own calculations.

4.2 The contribution of alcohol use and smoking on the life expectancy gender gap

From the latest available data, it becomes clear that there are differences between the Central Asian countries as to what extent alcohol use and smoking have an effect on the gender differences in life expectancy at birth (Figure 5). In Kazakhstan and Turkmenistan, the contribution of smoking is bigger than the contribution of alcohol use. For Kyrgyzstan, Tajikistan, and Uzbekistan this is the other way around and alcohol use contributes more compared to smoking. Both alcohol use and smoking have the biggest relative and absolute influence in Kazakhstan compared to other countries and absolute contributions are most equal. Of the 8.03-year difference in life expectancy between men and women, 2.4 years (30%) is a result of alcohol use and 2.59 years (32%) is the result of smoking. For Kyrgyzstan, the absolute contribution of alcohol use to the 6.95-year gender difference is 1.62 years (23%) and the contribution of smoking is 1.5 years (22%). In Tajikistan the absolute contributions of alcohol and smoking are the lowest, however, the gender gap of 3.81 years is also the lowest. 0.62 Years (16%) is due to alcohol use and 0.13 years (3%) is due to smoking. Relatively speaking the smoking-attributable mortality in Tajikistan is the lowest in Central Asia. In Turkmenistan, smoking accounts for 1.27 years (18%) whereas the contribution of alcohol use is lower and accounts for 1.01 years (15%) to the 6.92-year gender gap in life expectancy. Here alcohol-attributable mortality is relatively the lowest in the region. Lastly, in Uzbekistan smoking contributes for 0.57 years (12%) and alcohol use for 0.87 years (19%) to the 4.69-year gender gap.

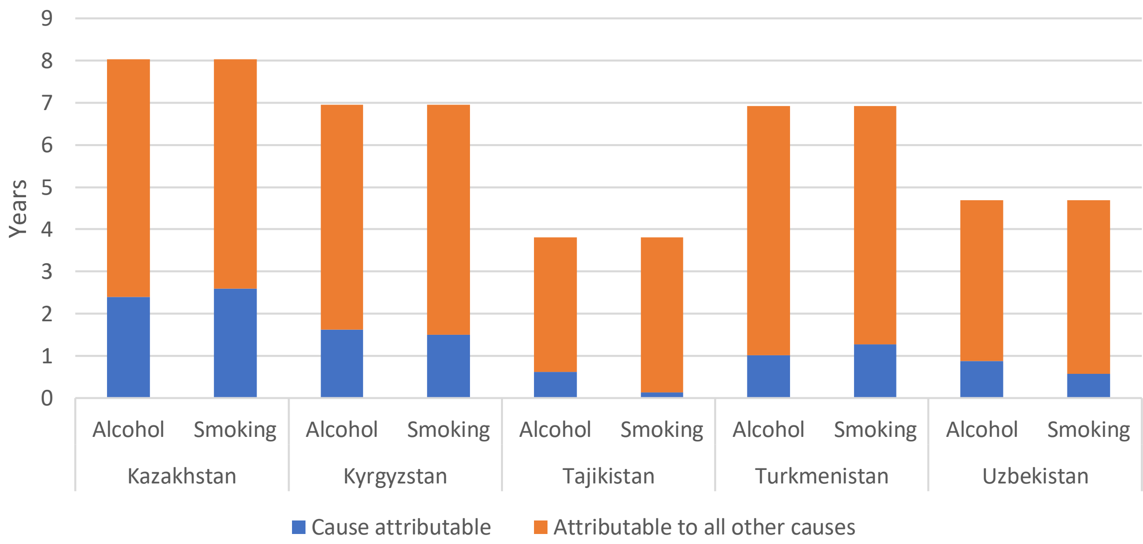


Figure 5: Absolute contribution of alcohol use and smoking to the gender gap in life expectancy at birth. Latest available data: Kazakhstan: 2017; Kyrgyzstan, Tajikistan, Uzbekistan: 2016; Turkmenistan: 2015. Source data: WHO (2021d), own calculations

4.3 Changing contribution of alcohol use on the gender gap in life expectancy

In Central Asia, alcohol-related mortality explains 18% of the difference between male and female life expectancy at birth between 1981 and 2017. In absolute numbers the alcohol-related mortality on average caused men to live between 0.72 years (Uzbekistan) and 2.71 years (Kazakhstan) shorter compared to women during this period. Between countries, the average relative contribution differs between 26% in Kazakhstan to 11% in Turkmenistan.

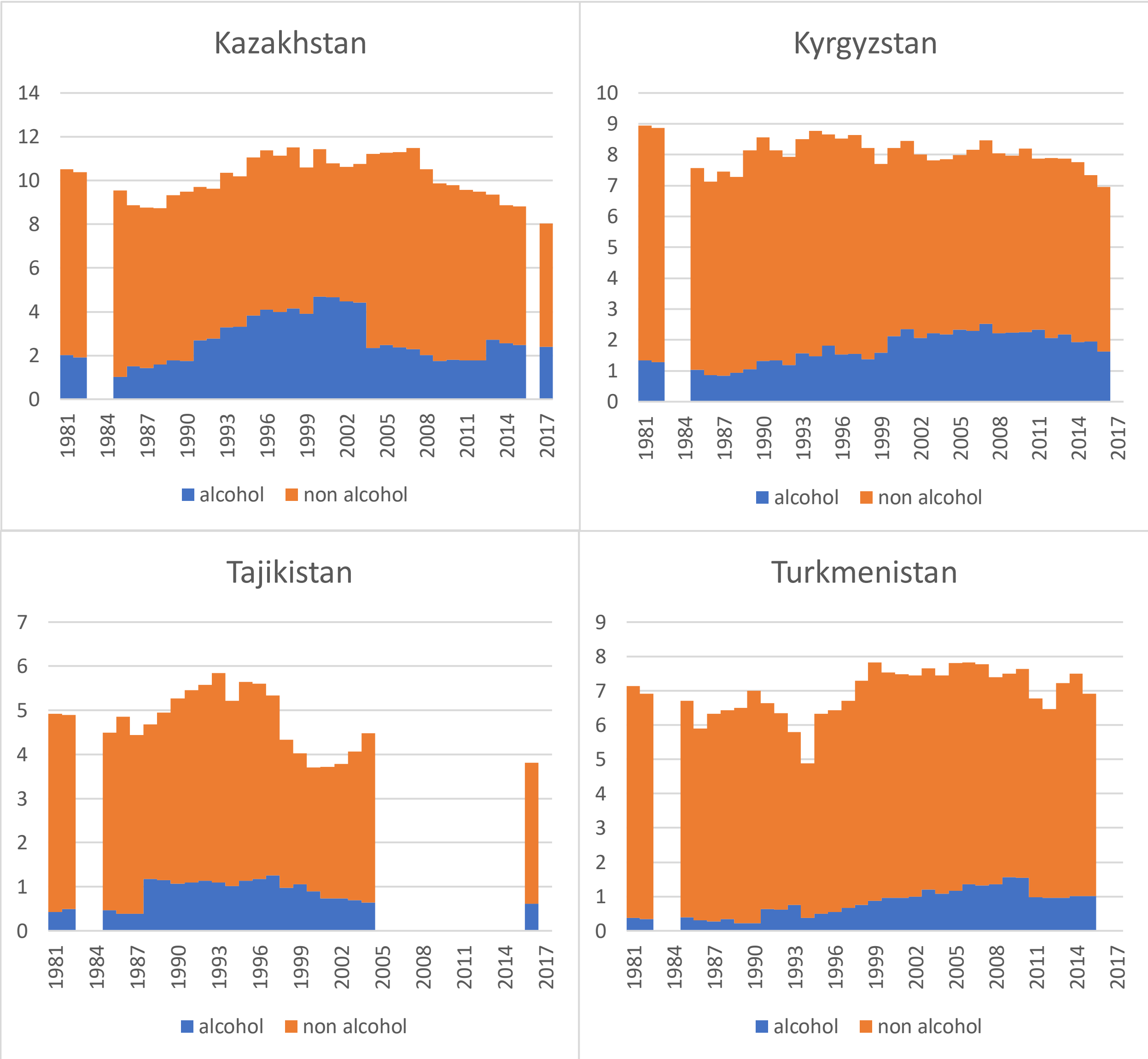
When comparing the most recent situation with the start of the period the relative contribution of alcohol use fluctuated and increased for all countries (Figure 6). Additionally, the contribution in absolute years increased with on average around 4 months. The fluctuation was especially big in Kazakhstan ranging from 4.69 years in 2000 to 1.01 years in 2009 and low in Uzbekistan between 0.51

years in 1987 and 1.16 years in 2005. Some caution to the results is needed as the different classification lists of the WHO dataset resulted in differences in the estimated contributions. For example, in Kazakhstan between 2004 and 2012, the values are lower due to the condensed coding list.

During the 1980s all countries show a similar pattern of a decreasing contribution of alcohol use. However, how the absolute and relative contribution evolved after that is different between the countries. Kazakhstan and Tajikistan experienced the biggest contribution of alcohol use to the gender difference in life expectancy at birth during the second half of the 1990s and the first half of the 2000s. Whereas Kyrgyzstan, Turkmenistan, and Uzbekistan experienced this later from the second half of the 2000 onwards. The highest absolute contributions of alcohol are 4.69 years in Kazakhstan in 2000, 2.36 years in Kyrgyzstan in 2001, 1.26 years in Tajikistan in 1997, 1.56 years in Turkmenistan in 2009, and 1.16 years in Uzbekistan in 2005. In line with this is that even though the contributions are higher in the most recent situation than in 1981 during these periods the absolute and relative contributions were even higher. The lowest contributions were during the 1980s and were 1.01 years in Kazakhstan in 1985, 0.84 years in Kyrgyzstan in 1987, 0.38 years in Tajikistan in 1986/1987, 0.22 years in Turkmenistan in 1989, and 0.51 years in Uzbekistan in 1987.

Not only the absolute contribution of alcohol use to the gender gap in life expectancy is higher in the most recent situation compared to 1981, the relative contribution is also higher (Table 2). Besides, the trend occurred in the same way, with for all countries a slight decrease, followed by an increase and decrease. Peaks in the highest relative contributions were reached in 2001 in Kazakhstan, 2007/2011 in Kyrgyzstan, 1999 in Tajikistan, 2009 in Turkmenistan, and 2005 in Uzbekistan.

When looking at the absolute and relative contributions it becomes clear that when the gender gap in life expectancy narrows this is not the result of less alcohol-attributable mortality. In Uzbekistan there is some fluctuation and an overall decrease in the gender gap in life expectancy between 1990 and 2005 but the absolute contribution of alcohol remains more stable and increases in the end. The other way around is true for Tajikistan for example. Here the gender gap in life expectancy increases between 2000 and 2004, but the absolute contribution of alcohol decreases. This shows that additional factors play a role.



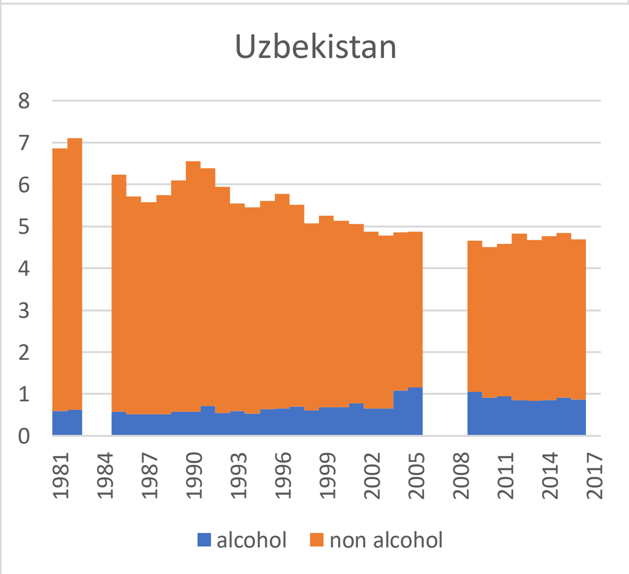


Figure 6: The contribution of alcohol-attributable mortality to the gender gap in life expectancy at birth in Central Asia between 1981 and 2017. Source data: WHO (2021d), Own calculations.

	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
1981	19%	15%	9%	5%	9%
1982	18%	14%	10%	5%	9%
1985	11%	14%	10%	6%	9%
1986	17%	12%	8%	5%	9%
1987	16%	11%	9%	4%	9%
1988	18%	13%	25%	5%	9%
1989	19%	13%	23%	3%	9%
1990	19%	15%	20%	3%	9%
1991	28%	16%	20%	9%	11%
1992	29%	15%	20%	10%	9%
1993	32%	18%	19%	13%	11%
1994	32%	17%	20%	8%	10%
1995	35%	21%	20%	8%	11%
1996	36%	18%	21%	9%	11%
1997	36%	18%	24%	10%	13%
1998	36%	17%	22%	10%	12%
1999	37%	20%	26%	11%	13%
2000	41%	26%	24%	13%	13%
2001	43%	28%	20%	13%	15%
2002	42%	26%	20%	13%	14%
2003	41%	28%	17%	16%	14%
2004	21%	28%	14%	15%	22%
2005	22%	29%		15%	24%
2006	21%	28%		17%	
2007	20%	30%		17%	
2008	19%	28%		18%	
2009	18%	28%		21%	23%
2010	18%	27%		20%	20%
2011	18%	30%		14%	21%
2012	19%	26%		15%	18%
2013	29%	28%		13%	18%
2014	29%	25%		13%	18%
2015	28%	26%		15%	19%
2016		23%	16%		19%
2017	30%				

Table 2: The relative contribution of alcohol use to the gender gap in life expectancy in Central Asia between 1981-2017. Source data: WHO (2021d), Own calculations.

4.4 Changing contribution of smoking on the gender gap in life expectancy

Smoking-related mortality explains 31% of the gender gap in life expectancy at birth in Central Asia between 1981 and 2017. Between the five countries, the relative influence of smoking ranges on average from 52% in Kazakhstan to 21% in Tajikistan. During this period, the absolute contribution on average causes women to live between 5.31 years (Kazakhstan) and 1.01 years (Tajikistan) longer compared to men.

For all countries, the relative contribution of smoking to the gender gap in life expectancy was not stable over time and decreased when looking at 1981 and the most recent situation (Figure 7). In terms of absolute contribution, the number of years men live shorter, as a result of smoking, reduced by at least half. In the case of Tajikistan, the reduction was the greatest with 93% from 2.96 years to 1.5 months. Although the relative and absolute contribution is lower in the most recent situation this has not always been the case. All countries first experience a (slight) increase in the 1980s and 1990s. In Central Asia, the relative and absolute contribution was the highest in 1987 with a difference of 3.27 years and accounted for 49% of the gender gap in life expectancy at birth. Kazakhstan showed the biggest difference between men and women in 1998 with a difference of 6.82 years (59%).

At the beginning of the period, the countries show a levelled trend and a minor increase in the contribution of smoking to the difference in male and female life expectancy. During the late 1990s and 2000 the contribution started to decrease. Whereas Kazakhstan and Tajikistan experienced the lowest contribution in the most recent year (2.59 in 2017 and 0.13 in 2016 respectively), Kyrgyzstan, Turkmenistan and Uzbekistan experienced the lowest absolute and relative contribution of smoking in a different year For Kyrgyzstan and Uzbekistan this was 1.49 years and 0.42 years in 2015 and 0.57 years in 2008 for Turkmenistan. The highest contribution for the five countries was during the 1980s. Kazakhstan it was in 1998 and 6.82 years, for Kyrgyzstan 4.1 years in 1981, for Tajikistan 2.16 years in 1987, for Turkmenistan 3.14 years in 1985, and 2.67 years in 1986 in Uzbekistan.

Just as the absolute contribution is the relative contribution of smoking to the gender gap in life expectancy lower in 1981 compared to the most recent situation (Table 3). The trend of the also shows a similar pattern in all five countries with first a more or less stable contribution or a slight increase, followed by a decrease. The highest relative contributions were between 1985 and 1992, whereas the lowest are in more recent years; 2017 in Kazakhstan, 2015 in Kyrgyzstan and Uzbekistan, 2016 in Tajikistan, 2008 in Turkmenistan.

Taking into account the absolute and relative contribution of smoking the results show differences between countries. In the case of Turkmenistan and for some years in Tajikistan, the gender gap in life expectancy is increasing while the absolute and relative contributions are decreasing. The decrease in relative contribution suggests other additional factors play a role, and the narrowing gender gap in life expectancy is only partly a result of a decrease in smoking. In the case of Kazakhstan and Uzbekistan, there is both a decrease in the gender gap in life expectancy as well as an absolute and relative decrease in the contribution of smoking. It indicates that smoking plays a role in a narrowing gap but other factors play a role as well.

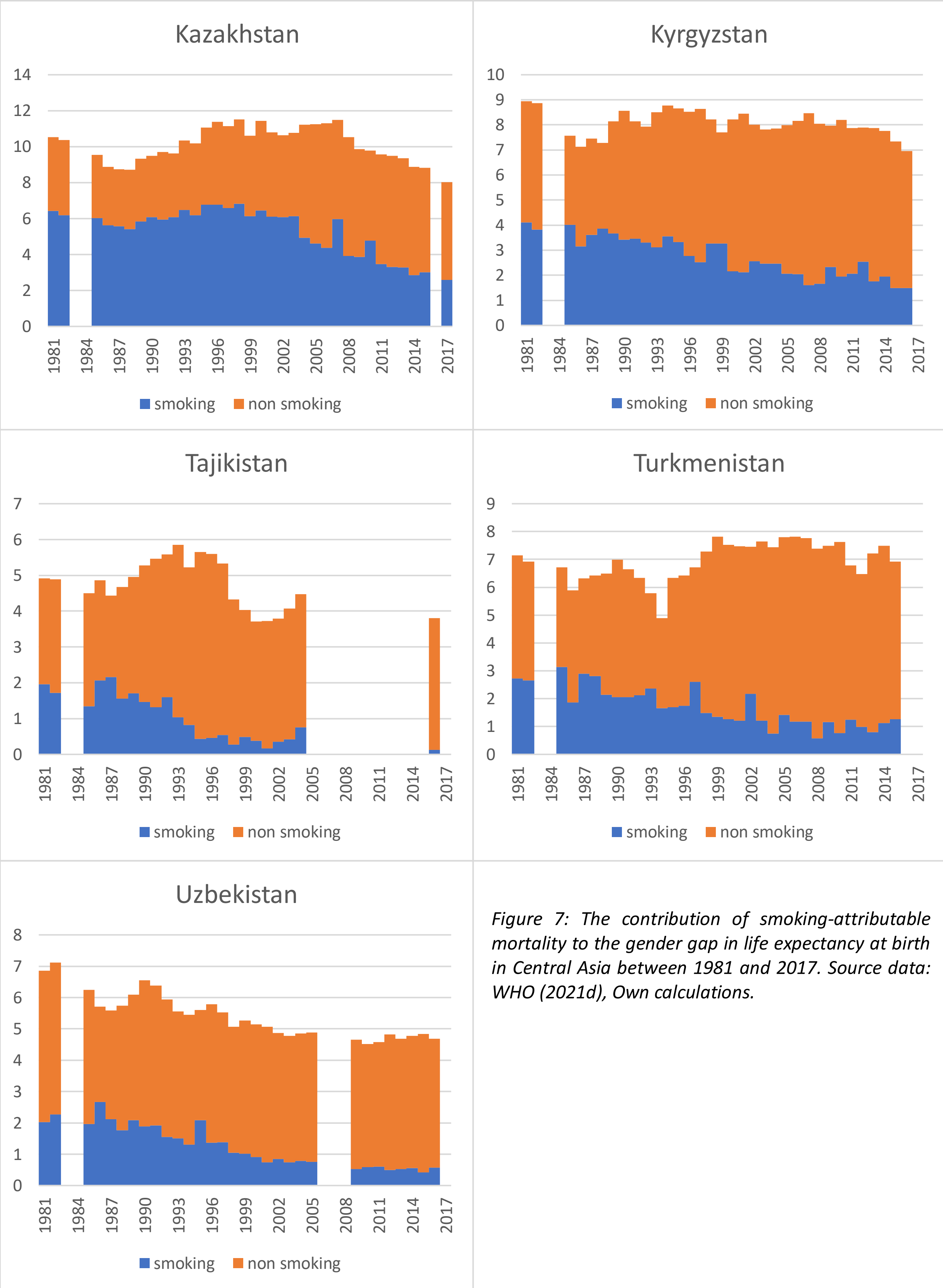


Figure 7: The contribution of smoking-attributable mortality to the gender gap in life expectancy at birth in Central Asia between 1981 and 2017. Source data: WHO (2021d), Own calculations.

	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
1981	61%	46%	40%	38%	30%
1982	60%	43%	35%	38%	32%
1985	63%	53%	30%	47%	31%
1986	63%	44%	43%	32%	47%
1987	64%	48%	49%	46%	38%
1988	62%	53%	33%	44%	31%
1989	63%	45%	34%	33%	34%
1990	64%	40%	28%	29%	29%
1991	61%	42%	24%	31%	30%
1992	63%	42%	29%	33%	26%
1993	63%	37%	18%	41%	27%
1994	61%	40%	16%	34%	24%
1995	61%	38%	8%	27%	37%
1996	60%	33%	8%	27%	24%
1997	59%	29%	10%	39%	25%
1998	59%	40%	6%	20%	21%
1999	58%	42%	12%	17%	19%
2000	56%	26%	10%	17%	18%
2001	57%	25%	5%	16%	15%
2002	57%	32%	9%	29%	17%
2003	57%	31%	10%	16%	15%
2004	44%	31%	17%	10%	16%
2005	41%	26%		18%	15%
2006	39%	25%		15%	
2007	52%	19%		15%	
2008	37%	21%		8%	
2009	39%	29%		15%	11%
2010	49%	24%		10%	13%
2011	36%	26%		18%	13%
2012	35%	32%		15%	10%
2013	35%	22%		11%	11%
2014	32%	25%		15%	12%
2015	34%	20%		18%	9%
2016		22%	3%		12%
2017	32%				

Table 3: The relative contribution of smoking to the gender gap in life expectancy in Central Asia between 1981-2017. Source data: WHO (2021d), Own calculations.

5. Discussion and overall conclusion

5.1 Summary of results.

In Central Asia, women live on average 6.1 years longer compared to men in the most recent situation. The average gender gap in life expectancy within the countries and research period ranges from 10.1 years (Kazakhstan) to 4.7 years (Tajikistan). Over time the gender gap showed subsequently a decrease, an increase, and a slight decrease again.

In the most recent situation, alcohol-attributable mortality accounts on average for 21% (1.30 years) of the gender difference in life expectancy in Central Asia and smoking-attributable mortality accounts for 18% (1.21 years). In Kyrgyzstan, Tajikistan, and Uzbekistan the contribution of alcohol is bigger than the contribution of smoking and in Kazakhstan and Turkmenistan, the contribution of smoking is bigger. The trend in alcohol-attributable mortality first showed a decrease and subsequently increased and decreased again, but the average contribution in Central Asia remains higher than in 1981 (0.95 years, 11%). The average contribution of smoking-attributable mortality remained more stable at first and decreased in the 1990s and is at a lower level than 1981 (3.45 years, 43%). The contribution of alcohol or smoking-attributable mortality followed more or less the same trend in all five countries, however, differences between them are large. Kazakhstan is having the highest absolute and relative contributions and Tajikistan is having the lowest.

5.2 Discussion of findings

5.2.1 Evaluation of the gender gap in life expectancy Central Asia

In the most recent situation, Central Asian women live on average 6.1 years longer compared to men. This is similar to eastern European countries that are former USSR republics (Trias-Llimós & Janssen, 2018). With regards to western Europe, the gender gap in life expectancy in Central Asia is bigger.

In all five countries the gender gap in life expectancy is lower in the most recent situation compared to 1981 and on average decreased from 7.7 years to 6.1 years. The trend in the gender gap in life expectancy shows first a slight decrease following by a small increase and decrease again. The outcomes of the gender gap in life expectancy of this analysis are in line with previous studies (Falkingham, 1999; Cashin et al., 2002; Cockerham et al., 2004) and the hypothesis. Falkingham and Cockerham concluded that the differences in male and female life expectancy increased during the 1990s for fast transitioning countries, like Kazakhstan and Kyrgyzstan, which is visible in the presented results. However, it seems that not only for the two fast transitioning countries the gap increased during this period but also for Tajikistan and Turkmenistan. There is no research that focused on a more recent period. These results thus give a first overview of the difference in male and female life expectancy and the slow decrease that followed after the 1990s.

5.2.2 Evaluation of the contribution of alcohol use and smoking

This study aimed for a systematic approach by looking at the contribution of alcohol use and smoking to the gender gap in life expectancy in Central Asia over a period of about 36 years. Like previous research on the influence of lifestyle (Denton & Walters, 1999; Rochelle et al., 2015; Aboulgha et al., 2016; Trias-Llimós & Janssen, 2018), this study has shown that lifestyle does play a role in gender differences in life expectancy. Besides Cockerham et al. (2004) and Guillot et al. (2013) already pointed out that behavioural factors like alcohol use and smoking are common and possibly explain a part of this difference, which is underlined by these results.

The outcomes show a first insight into the absolute and relative contribution of alcohol use and smoking to the difference between male and female life expectancy in Central Asia. The main hypothesis was that men consume more alcohol and smoke more than women, which would lead to a higher life expectancy for women. Looking at mortality differences as a result of smoking and alcohol consumption it can be concluded that the gender gap in life expectancy can indeed, to a certain extent, be explained by alcohol use and smoking resulting in a higher life expectancy among females. In the most recent situation alcohol use explains on average 21% of the gender gap in life expectancy in Central Asia and smoking explains on average 18%. Country differences are large and as expected the contributions are the biggest for Kazakhstan and Kyrgyzstan as a consequence of bigger differences between male and female drinking and smoking patterns.

On average the contribution of alcohol-attributable mortality went from 0.9 years (11%) in 1981 to 1.30 years (21%) in the most recent situation. When looking at the trend it first showed a decrease and subsequently increased and decreased again. This waved trend is visible in all five countries and the contribution of alcohol use started to first increase in the 1990s. The increase can be explained by the reversal of the strict anti-alcohol campaigns which were initiated by Gorbachev (Davletov et al., 2016). In 1990 and 1991 the Central Asian countries became independent states and Gorbachev's campaign was no longer put into practice. The timing of the decrease differs more between the countries but is to a great extent in accordance with what was expected. The difference in classification lists causes more uncertainty in drawing conclusions for Turkmenistan and because of missing data for Tajikistan the trend is not fully shown. However, the observations can be a result of policy implementations, which in Kazakhstan happened in the early 2000s whereas in Turkmenistan and Uzbekistan it occurred in the late 2000s. Kazakhstan was the first country to implement a National Policy Plan and an action plan in 1999 to reduce alcohol consumption. The other countries followed later, Tajikistan in 2005, Uzbekistan in 2011, and Kyrgyzstan in 2012 (WHO, 2017 & 2019). The implementation of the policies as well as taxation reduced the affordability and lead to a lower turnover. During this period Turkmenistan is the only country which does not have a policy on alcohol consumption.

The contribution of alcohol-attributable mortality does not fully explain fluctuations in life expectancy. although there are some similarities between the trend in alcohol use and the trend in the gender gap in life expectancy, for example in Kazakhstan during the 1990s, in other countries the trends oppose each other. This becomes especially clear in Tajikistan or Uzbekistan, in the case of Tajikistan contribution of alcohol use remains fairly stable, but the gender gap in life expectancy fluctuates. In the case of Uzbekistan, the contribution of alcohol use slowly increases but the gap in life expectancy decreases. Explanations of why this occurs must be found in other reasons, but a possible explanation for Tajikistan could be the reduction of child mortality in Tajikistan (Falkingham, 1999).

In the Central Asian countries, the contribution of smoking-attributable mortality remained more stable at first and later decreased. The contribution went from on average 3.5 years (43%) in 1981 to 1.21 years (18%) in the most recent situation and is visible in all five countries. The trends are however different from what was expected. Especially for Kazakhstan, Kyrgyzstan, and Uzbekistan, the decrease happened earlier. The outcomes of Tajikistan might indicate a slight increase before 2005, but due to missing data for the period after this is hard to conclude. The timing of the decrease in smoking is less related to the prevalence. Nevertheless, the implementation of policies, advertisement bans, taxes, and tobacco control can still explain the reduction in the contribution of smoking to the gender difference in life expectancy (WHO, 2016). Except for Turkmenistan, the countries adopted these policies during the late 1990s or early 2000s which is around the same time as there is a decrease in the contribution. Since men smoke much more compared to women the policy implementations affected their smoking habits much more (Clark & Peck, 2005; Jasilionis et al., 2007).

When relating this to the overall difference between male and female life expectancy it seems that the contribution of smoking explains the fluctuation in the gender gap in life expectancy better than the contribution of alcohol use. With the exception of Turkmenistan, the trend of the contribution of smoking shows a similar pattern as the trend in the gender gap in life expectancy. Turkmenistan is the only country in which deaths occurring because of smoking, is not included in the top 10 causes of death (GBD, 2013), suggesting other causes will have a bigger impact on the gender gap in life expectancy.

Lastly, there are differences between the Central Asian countries as to what extent alcohol use and smoking contribute to the gender gap in life expectancy. In all countries, men are more exposed to alcohol use and smoking, and they all implemented policies for regulations and bans on advertisement of alcohol or tobacco. Yet the average relative contribution of alcohol ranges from 26% to 11% and the average relative contribution of smoking ranges from 52% to 21% showing large differences between the countries. Kazakhstan and Kyrgyzstan show higher contributions than Tajikistan, Turkmenistan, and Uzbekistan. There are some country-specific factors that explain this, for example Uzbekistan improved the health care system more than the other countries and in Turkmenistan the government has a monopoly when it comes to alcohol production (Neufeld et al., 2011; Nazarovna et al., 2016). However, the main reason for the difference might be cultural and religious differences. These are to some extent related to the ethnic differences that play a role in the country differences in the contribution of alcohol use and smoking to the gender gap. As Davletov and colleagues (2016) pointed out ethnic Russians have higher mortality rates from for example tuberculosis because of alcohol use compared to ethnic Kazakhs and lower but similar results were found for Kyrgyzstan. The share of Russians is smaller in Tajikistan and Uzbekistan, but similar to Turkmenistan. When considering religion in this context, it explains why the contribution of Turkmenistan is lower compared to Kyrgyzstan even though the share of Russians is similar, the share of Muslims is higher in Kyrgyzstan (Neufeld et al., 2011). Combining the cultural difference of ethnicities and religion it explains why the differences in life expectancy and the contribution of alcohol and smoking to the gender gap in life expectancy range from a higher level in Kazakhstan to a lower level in Tajikistan.

5.3 Evaluation of data and methods

Using the WHO mortality database causes some implications to calculate life expectancy and estimate alcohol or smoking-attributable mortality. First, since the population data from the WHO is missing data for some years and countries it was compared to the UN population prospects. However, the UN data is based on estimates and showed differences with regards to peaks in trends in comparison to the WHO population data. Therefore, it was decided to use the WHO population data because it matches the mortality data as it is from the same dataset. Second, since the WHO uses different classification lists for the countries and years selected, adjustments were made to estimate alcohol-attributable mortality. Causes of death were grouped and chosen so that initially no difference between countries and/or years would occur. The outcome differences that are due to the use of different lists occur in all countries but are especially clear in Kazakhstan between 2004 and 2012, in Tajikistan before 1988, and in Uzbekistan before 2004. As a result, the interpretation of the data is more difficult due to these differences in cause of death classification lists. Third, and in line with the second issue is that although the adjustments were made to make the outcomes comparable, for some countries for some years certain data on causes of death was not available and some caution to the outcome is needed. For some countries and years, the influence of alcohol on the gender gap in life expectancy at birth is therefore somewhat underestimated. An example of this would be the lack of data on mental and behavioural disorders due to substance use for Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan for the earlier periods within this research. Fourth, using WHO lung cancer mortality data to estimate smoking-attributable mortality also caused some inconsistency as a result of missing data. Even though there was lung cancer data for all countries and all years included in the dataset, in some instances the contribution of smoking is still underestimated, for example there is incomplete lung data cancer for Tajikistan in 2016 as there was no data on cause of death under code C33 (ICD-10).

Analysing the contribution of alcohol use and smoking to the gender gap in life expectancy at birth in Central Asia builds upon methods used in previous research and was analysed systematically. There are some aspects that must be noted when using these methods to estimate alcohol or smoking-attributable mortality because although it is a valid and commonly used method it is based on an estimation technique.

The estimated contribution of alcohol-attributable mortality was based on WHO cause-specific mortality data and the fractions of the GBD study. Since this research used mortality data which is partly attributable to alcohol use the prevalence data and relative risks determine the quality of the estimation (Rey & Jougla, 2014). According to Trias-Llimós and Janssen (2018) applying this method is more accurate compared to methods only using data on the underlying cause of death. Additionally, compared to other methods, using the GBD estimation causes the least underestimations and requires fewer assumptions (Trias-Llimós et al., 2018). Yet, the use of GBD fractions has some implications that may affect the outcomes of this research. First and as mentioned before the difference in coding practice in the GBD study are affecting estimates, but not much is known as to what extent this differs (Agardh et al., 2016). Because between countries these practices differ and the difficulty of making an accurate diagnosis causes underreported alcohol-attributable deaths. Second, the used fractions may be less reliable as alcohol-attributable mortality may be underreported. Shield and Rehm (2015) came to this conclusion for Russia and surrounding Eastern European countries. Given the shared history of these countries and, according to WHO data the incompleteness of death registration with cause-specific information, alcohol-attributable deaths might be underreported (World Bank, 2021b). A third limitation is concerned with the GBD estimates on alcohol-attributable mortality and the relation to other causes of death and mortality outcomes (Agardh et al., 2016). When applying the fractions of the GBD it is automatically assumed that countries are comparable, nevertheless, Agardh and colleagues state there might be interactions between other risk factors and alcohol use that are unmeasured and differ between countries. However, the key strength of using the GBD study is that mortality related to alcohol use is uniformly and systematically defined, which makes it comparable over time and across different countries (Agardh et al., 2016).

To estimate smoking-attributable mortality, the indirect and simplified Peto-Lopez method is commonly used but has some implications. The first one is that the differences between countries are underestimated as different populations experience different risks of dying from smoking. Because the analysis depends on the relative risks of the ACS-CPSII study in 1982–1988 of dying from smoking and relative risks are not specific for each country and the differences between countries are therefore underestimated (Janssen, 2020b). Additionally, these relative risks are independent which will not affect the country nor the gender differences in the timing of the impact but could influence the timing of the maximal or minimal impact resulting in a potential underestimation (Janssen, 2021). On the contrary, smoking-attributable mortality may be overestimated as lung cancer mortality rates might be higher due to other factors, like environmental air pollution, indoor air pollution because of coal-burning practices in households, or asbestos (Tyczynski et al., 2003; Hashim & Boffetta, 2014; Kaidarova et al, 2019). The second one is that external environmental factors may affect lung cancer mortality rates. However, using this method assumes that the same ratio can be used for each country, whereas lung cancer rates as only a result of smoking may differ between countries (Janssen & Spriensma, 2012). Yet, this indirect and simplified method is commonly used and makes it possible to deal with issues like incomplete data and uses objective data on smoking prevalence. Besides, the reliance on high-quality cause of death information also includes smoking intensity and duration which relies on high-quality data about causes of death (Pérez-Ríos & Montes, 2008; Preston et al., 2021).

5.4 Recommendations for further research

This research contributed to gain more insights into the reasons behind the gender differences in life expectancy in Central Asia and provided a first overview of the impact of alcohol use and smoking on this. Yet, it rose new questions for further research. To begin with the fact that alcohol use and smoking do not fully explain the gender gap in life expectancy, suggests other factors play a role that are more of influence. Also, it did not examine the cumulative impact of lifestyle factors as, in this research, the calculated contributions only apply to specific behaviour. It would be interesting to see the impact of the combination of alcohol use and smoking or to include other behavioural risks factors. Besides this, the analysis looks at the population as a whole within the different Central Asian countries, which limits the understanding of the role of ethnic or cultural differences in the contribution of alcohol and smoking to the difference between male and female life expectancy. Along the lines of the study of Davletov and colleagues (2016), this analysis indicated that ethnic and/or religious differences might influence patterns in alcohol use or smoking. Possible future research could therefore focus on the role of religion and or ethnicity in relation to differences in life expectancy. Lastly, this research focuses only on differences in life expectancy between men and women and did not consider the (negative) effects of alcohol use and smoking on health outcomes. Further research could therefore also aim at gaining more insights in the gender differences in years lost due to a disability or disability-adjusted life years.

5.5 Recommendations for policymaking

Given the outcomes of the analysis, the implementation of previous bans and taxes showed a beneficial outcome in terms of a decrease in cause attributable mortality of both alcohol and smoking, and a decrease in the contribution to the difference between male and female life expectancy. To further decrease the gender gap in life expectancy in Central Asia more policies or restrictions including taxes, on alcohol and smoking retail would be useful. New policies should focus on both the reduction of health inequalities between men and women and at the same time promote healthy lifestyles to create societal gains for the population as a whole. Moreover, they are needed to ensure a decrease in the gender gap in life expectancy and could possibly lead to a higher life expectancy in general. Since men drink or smoke much more than women, new regulations, interventions, or preventive policies that focus on discouraging Central Asian men from drinking or smoking will be helpful.

By creating different policies for smoking and alcohol the issues can be tackled more at the core. Looking at the implemented regulation against smoking, the absolute and relative contribution to the gender gap in life expectancy decreased and new policies could reduce smoking prevalence and smoking-attributable mortality even further. In doing so the Central Asian countries can take lessons from good practices in European countries (Janssen, 2020b). The policies implemented to reduce alcohol consumption show a similar, but smaller effect on the gender gap in life expectancy. Additional policies and regulations will help to trigger a faster decrease in alcohol-attributable mortality. However, when tackling the issues related to alcohol use and smoking behaviour it is important that this is done within the context of the country itself because there are differences between the countries as to what extent alcohol and smoking are influencing gender differences in life expectancy.

5.6 Overall conclusion

Within Central Asia, life expectancy was found to be higher among females as a result of gender differences in alcohol use and smoking. Although there are some implications with the data, the systematic analysis shows both similarities and differences between the Central Asian countries and revealed the trends in the contribution of alcohol- and smoking-attributable mortality to the gender gap in life expectancy between 1981 and 2017. How the trends of alcohol-attributable mortality and smoking-attributable mortality have developed is similar for all five countries and can be explained by policy changes. On average the contribution of alcohol-attributable mortality increased from 11% in 1981 to 21% in the most recent situation and results in a 1.30-year gender difference in life expectancy. Smoking-attributable decreased from 43% in 1981 to 18% and accounts for a difference of 1.21 years in life expectancy. Nonetheless, the difference, as to what extent alcohol use and smoking play a role in the gender gap in life expectancy, between countries is large and is likely a result of cultural differences in ethnicity and religion. All in all, country differences must be considered when conducting future research and when formulating new policies.

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Appendix 1 – Data availability

	Available period*	
Country	WHO mortality database	IHME Global Burden of disease
Kazakhstan	1981-1982, 1985-2015, 2017	1990-2017
Kyrgyzstan	1981-1982, 1985-2016	1990-2017
Tajikistan	1981-1982, 1985-2004, 2016	1990-2017
Turkmenistan	1981-1982, 1985-2015	1990-2017
Uzbekistan	1981-1982, 1985-2005, 2009-2016	1990-2017

*relevant for this research
Sources: IHME (2021b) & WHO (2021)

Appendix 2 – Supplementary information on the WHO mortality database

Table WHO mortality database – data availability per list

	ICD country code	ICD 9 list 09N*	ICD 9 list 09A/09B	ICD 10 list 101	ICD 10 list 103	ICD 10 list 104
Kazakhstan	4182	1981-1982, 1985-1990	1991-2003	2004-2012	2013-2015, 2017	
Kyrgyzstan	4184	1981-1982, 1985-1999				2000-2016
Tajikistan	4301	1981-1982, 1985-2004			2016	
Turkmenistan	4302	1981-1982, 1985-1990, 1994-1998	1991-1993	1999-2015		
Uzbekistan	4335	1981-1982, 1985-2003			2004-2005, 2009-2016	

* This list contains an additional set of codes that are uniquely used for Kazakhstan, Kyrgyzstan, and the former USSR for some years (WHO, 2021). Some causes of death are additionally coded into other broader groups. These additional codes will not be used since they are less specific and contain more causes of death under one code. For example, B47 Transport Accidents is registered under B47 as well as S47, however, the latter is categorised as Accidents and Adverse Effects which includes external causes as well (B48-B53).

Adjustments because of condensed data in ICD-10 list 101 condensed

- Cerebrovascular: removed remainder (codes: 1061, G45 & G4509-G459)
- Tuberculosis: removed remainder (codes:1025, B90 & B900-B909)
- Liver diseases: include alcoholic liver diseases and non-alcoholic cirrhosis and other chronic liver diseases
- External causes: includes accidental poisoning and all other external causes
- Mental disorders: broadened to substance use
- Pancreatitis and epilepsy will be removed completely to create initial consistency over time and within the countries. Pancreatitis: only data available for KAZ 2013-2015 & 2017; KGS 2000-2016; TJK 2016; UZB 2004-2005, 2009-2016 and incidence numbers are low. Epilepsy no data available for TKM after 1998.
- Other external causes: includes animal contact, drowning, exposure to mechanical forces, falls, heat fire and other hot substances, physical violence by firearm, poisoning, self-harm, and unintentional injuries based on Harrison et al. (2008).

Table of correspondence ICD-9 and ICD-10 code lists and GBD

Cause of Death	ICD 9th revision, Basic Tabulation List (condensed) List: 09A/09B	ICD10 Mortality Tabulation List 1 (condensed) List: 101	ICD10 3 (detailed) character list List: 103	ICD10 4 (detailed) character list List: 104	Global Burden of Disease 2020
All-cause	B00	1000	AAA	AAA	
Mental and behavioural disorders due to substance use	B215, B216	1056	F10-F19	F100-F199	Substance use disorders
Liver diseases	B347	1080	K70–K76	K700-K769	Cirrhosis and other chronic liver diseases
Ischemic heart disease	B27	1067	I20–I25	I200-I259	Ischemic heart disease
Cerebrovascular disease	B29	1069	I60–I69	I600-I698	Cerebrovascular disease Intracerebral haemorrhage
Transport accidents	B47	1096	V01–V99	V010-V99 (including all 3-digit codes in between)	Transport injuries
Colon and rectum cancer	B093 & B094	1030	C18–C21	C180-C218	Colon and rectum cancer
Oesophageal cancer	B090	1028	C15	C150-C159	Esophageal cancer
Larynx cancer	B100	1033	C32	C320-C329	Larynx cancer
Lip and oral cavity cancer	B08	1027	C00–C14	C000-C148	Lip and oral cavity cancer
Tuberculosis	B02	1005, 1006	A12–A19	A150-A199	Tuberculosis
External causes	B48-B56	1103	W00–Y98	W000–Y98 (including all 3-digit codes in between)	Animal contact, drowning, exposure to mechanical forces, falls, heat fire and other hot substances, physical violence by firearm, poisoning by carbon monoxide, poisoning by other means, poisonings, self-harm and unintentional injuries, unintentional firearm injuries, other unintentional injuries
Lung cancer	B101	1034	C33 C34	C33 C340-C349	
All other causes	All other codes	All other codes	All other codes	All other codes	