CASP, a Measure of Quality of Life in Old Age: Evaluation of Psychometric Properties and Association With Mortality. The HAPIEE Study.

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Declaration

I, Gyu Ri Kim, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Publications

At the time of submission of this thesis a paper consisting of substantial parts of Chapter 5.2 has been published in Ageing & Mental health. The complete reference is: Kim GR, Netuveli G, Blane D, Peasey A, Malyutina S, Simonovav G, et al. (2014). Psychometric properties and confirmatory factor analysis of the CASP-19, a measure of quality of life in early old age: the HAPIEE study Jul 26; 1-15.

Abstract

Recent literature has documented the importance of Control, Autonomy, Self-realisation, and Pleasure (CASP) scores, a measure of generic QOL in older age, in predicting subsequent all-cause mortality among older adults. However, there have been no large scale studies of the relationship between quality of life and mortality in the Central and Eastern Europe region and little is known about the potential mechanisms underlying this relationship. The main purpose of this study was to examine the predictive ability of CASP12v3 score for mortality in population samples from three countries from Central and Eastern Europe (CEE) and the former Soviet Union (FSU) (the Czech Republic, Russia, and Poland). Furthermore, this study aimed to explore the possible causal mechanisms through which quality of life may affect mortality risk. In order to fulfil the main purpose of the study, the psychometric properties of different CASP versions were evaluated. Various factors that influence the quality of life in early old age were also identified using the validated CASP scale.

Data from the prospective population-based HAPIEE (Health, Alcohol and Psychosocial factors in Eastern Europe) study was used. At the baseline survey, between 2002-2005, 28,947 men and women aged 45-69 years were recruited from Novosibirsk (Russia), Krakow (Poland) and seven Czech towns. Quality of life was assessed using CASP12v3. The analytic sample comprised 11,476 retired individuals aged 50 and older who completed the retirement questionnaire, including the questions on quality of life (Czech Republic n=2,742; Russia n= 3,804; Poland n=4,930). The main outcome variable was all-cause mortality. Deaths in the three cohorts were ascertained using local and national death registers.

The results of psychometric analyses have demonstrated that the 12-item version of CASP (CASP12v3) is a valid and reliable tool for assessing QOL in the CEE/FSU populations. Kaplan–Meier survival curves and log-rank test were used to compare the country-specific CASP12v3 tertile categories, and Cox proportional hazards regression was used to model the associations between CASP score and the risk of death after adjusting for a variety of possible covariates. Using structural equation modeling, mediation analyses were performed to quantify the direct and indirect effects of CASP on all-cause

mortality through behavioral, physical health, and social network pathways.

There was a significant graded relationship between CASP12v3 and all-cause mortality ($P < 0.001$). Compared with participants with a high QOL (tertile 1), participants with low QOL (tertile 3) had significantly a higher risk of death (age- and sex-adjusted HR: 2.60, 95% confidence interval (CI): 1.87 to 3.60 in Czech Republic; HR: 2.00, 95% CI: 1.63 to 2.45 in Russia; HR: 1.98, 95% CI: 1.61 to 2.44 in Poland. All these associations remained significant albeit somewhat attenuated after adjustment for socio-demographic variables, health behaviors and depressive symptoms (HR: 1.75, 95% CI: 1.21 to 2.51 in Czech Republic; HR: 1.70, 95% CI: 1.35 to 2.13 in Russia; HR: 1.43, 95% CI: 1.08 to 1.89 in Poland). However, when physical health variables were incorporated in the successive Cox regression model for further adjustment, the impact of low quality of life on all-cause mortality attenuated to statistical non-significance. Mediation analyses confirmed that low quality of life at baseline has a significant negative direct effect on survival. Moreover, physical health partially mediated the effect of baseline CASP12v3 score on mortality in the Czech Republic and Poland, while full mediation was indicated in the Russian data. Among Polish older adults, indirect effect of CASP12v3 on mortality risk was also mediated through frequency of contact with family.

These results indicate that the inverse association between CASP12v3 score and mortality risk is mediated by self-rated physical health status and frequency of contact with family, such that the impact of CASP12v3 score beyond these risk factors was less important. Therefore, strategies for improving survival at older ages should focus on control of these variables in the mediating process, particularly declines in physical health.

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List of abbreviations

ASMR	Age-standardised mortality rate
BHPS	British household panel study
BMI	Body mass index
CASP	Control, autonomy, self-realisation, pleasure
CCEE	Countries of Central and Eastern Europe
CFI	Comparative fit index
CVD	Cardiovascular disease
CHD	Coronary heart disease
CI	Confidence interval
ELSA	English longitudinal study of ageing
EQ-5D	EuroQol questionnaire
FSU	Former Soviet Union
GDP	Gross domestic product
HAPIEE	Health, Alcohol and Psychosocial factors in Eastern Europe
HR	Hazard ratio
HRQOL	Health-related quality of life
IQR	Interquartile range
MCAR	Missing completely at random
MAR	Missing at random
NMAR	Not missing at random
OR	Odds ratio
QOL	Quality of life

RMSEA Root mean square error of approximation

SD Standard deviation

SEP Socioeconomic position

SF-36 Short Form 36-item Health Survey

SHARE Survey of health ageing and retirement in Europe

TILDA The Irish longitudinal study of ageing

TLI Tucker lewis index

WRMR Weighted root mean square residual

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Chapter 1

Introduction

This chapter sets out the motivation to the thesis, highlighting the interest and novelty of examining older people's quality of life from countries of Central and Eastern Europe. The main research interests and hypotheses will also be briefly introduced in this chapter. The last section of this chapter will outline the overall structure of the thesis.

1.1 Ageing and quality of life

The proportion of adults aged 60 or over has been growing more than any other age groups over the past few decades, as a result of both longer life expectancy and declining fertility rates. According to official United Nations population estimates and projections for Europe, the percentage of aged 60 or older is projected to rise from 22% in 2012 to 34% of the population by 2050 (Eurostat, 2012a).

Understanding positive aspects of ageing in older adults is therefore an important public health priority in countries undergoing such demographic transition. Having such priority contributed to an exponential increase in the volume of research that is concerned with investigating older people's quality of life, risk factors influencing it, and its relationship with range of health outcomes. Despite the extensive research on quality of life, there is no generally agreed definition of quality of life. In the absence of a theoretically-grounded measure of quality of life in old age, measures of health status, such as Short Form-36 Health Survey (SF-

36) and Activities of Daily Living scales, have often been used to measure quality of life (Ware and Gandek, 1998a, Dalton et al., 2003, Saccomann et al., 2010, Li et al., 2014). This may not be optimal as these measures are based on proxies such as health, which draw on a set of normative assumptions about what a particular condition implies for individuals' quality of life, without necessarily taking full account of a person's current experience of life. In recent decades, there has been growing recognition that quality of life amongst older people is a complex and a multi-faceted concept. It incorporates all aspects of an individual's life, including social and physical environments, as well as the health and internal states of individuals (Lawton, 1991, Grundy and Bowling, 1999, Walker and Mollenkopf, 2007, Wang et al., 2010). As many older people are living longer and healthier lives, measures that reduce quality of life to ill-health only are no longer appropriate. Accordingly, there is need for more research on measures of quality of life that covers the positive and beneficial aspects of ageing rather than only focusing on the medical and social care aspects of old age.

In the literature, prospective cohort studies have consistently shown that positive quality of life in old age is associated with range of health outcomes, including mental and physical health and longevity. To date, much of the research that has investigated this relationship has been conducted in the context of disease and Health-related quality of life (HRQOL) that is, quality of life relative to one's health or disease status. HRQOL scales have been associated with increased risk of coronary heart disease (CHD), Type 2 diabetes, hospitalization, disability, and total mortality (Tsai et al., 2007, Otero-Rodríguez et al., 2010, Cavrini et al., 2012). In contrast, there has been comparatively little scientific research linking positive quality of life with later-life mortality (Chida and Steptoe, 2008, Steptoe

and Wardle, 2011, Steptoe et al., 2014). Another characteristic of existing quality of life research is its focus on sick and frail older people rather than healthy community-living older adults.

The percentage of older people aged 65 or more in countries of Central and Eastern Europe (CCEE) is currently lower than in the European region as a whole. For example, the proportion of elderly people in Czech Republic and Poland reached the levels of 15.6% and 13.6% in 2011 and it is projected to increase further (Eurostat, 2012b). This will eventually lead to the convergence in the proportion of older people in countries of this region. However, current studies of quality of life are mainly focused on Western populations and there is limited research investigating the impact quality of life has on longevity among older adults living in countries of Central and Eastern Europe (CCEE), as well as the range of factors that influence positive quality of life in this region.

CASP scale is a relatively new stand-alone measure of quality of life that has been specifically targeted to measure quality of life of older adults. This scale of quality of life has been developed as a reaction to the under-theorized nature of existing quality of life measures (Higgs et al., 2003, Hyde et al., 2003). It is based on the theory of need satisfaction, which assumes that quality of life in older ages is conceptualized as the degree to which human needs are satisfied in four life domains: Control, Autonomy, Self-realisation, and Pleasure. The combination of these four domains is seen as an accurate measure of positive functioning, and subjective quality of life in later life. An explicit aim of this scale is to distinguish overall quality of life from the factors that influence it, such as health and financial

circumstances (Diener, 2006). An appreciation of the association between CASP and mortality would highlight the need for interventions directed at promoting quality of life in old age, which would be useful for improving survival in later life.

1.2 Main research interest

The specific objectives of this PhD thesis are described in **Chapter 3**. In general, this research concentrates on issues that so far have not been addressed in CCEE; such as the psychometric validation of the CASP instrument and identification of possible predictors of CASP in Central and Eastern European populations, and the role of CASP score in predicting later-life mortality within CCEE, taking into account other available risk factors. Among the socioeconomic factors, the main focus is on education, household amenities, and material deprivation of individuals. Among psychosocial factors, this project concentrated on depressive symptoms and relationship with family and friends.

1.3 Study design and data

The data were collected as a part of international HAPIEE study in three Central and Eastern European countries (CCEE): the Czech Republic, Poland, and Russia. In each country, the data came from a national sample of the populations. The study and data will be described in detail in the Methods chapter.

1.4 Structure of the thesis

This chapter is followed by Background (**Chapter 2**), which covers a general overview of trends in mortality in CCEE, the conceptualization of quality of life,

review of the literature on the relationship between CASP and mortality, and a description of possible mechanisms linking CASP and mortality. In **Chapter 3**, the overall aim of the thesis, specific objectives and related hypotheses will be described. **Chapter 4** then describes the data used for analysis and the steps used in the statistical analysis of the data. In **Chapter 5**, results are presented in several parts: 1) Descriptive characteristics of study subjects and populations, 2) Psychometric evaluation of CASP scales, 3) Key predictors of CASP in the HAPIEE (Health, Alcohol and Psychosocial factors In Central and Eastern Europe) study , 4) The association between baseline CASP score and all-cause mortality using Cox proportional hazards models, 5) Possible mechanisms linking CASP and subsequent mortality: estimation of direct and indirect effects of CASP12v3 on all-cause mortality through mediators, **Chapter 6** summarizes the main findings of thesis in relation to stated aims and hypothesis. It then compares the findings with the existing literature, discusses various methodological aspects of the study that could affect its findings and highlights implications for future research and policy. Finally, **Chapter 7** lists the conclusion of this project.

Chapter 2

Background

This chapter will first introduce the trends in mortality in Eastern Europe and the former Soviet Union. The different approaches to measuring quality of life and the conceptual background to the CASP-19 measure of quality of life will be presented. Next, the literature on relationships between quality of life and a range of risk factors of CASP, ranging from demographic characteristics to social relationships, as well as its relationship with later-life mortality will be reviewed. While focusing on research reports that use the CASP measure of quality of life, the review also incorporates insights from the broader literature examining influences upon subjective well-being. This chapter will also describe the theoretical conceptual model showing how older people's quality of life may be related to mortality.

2.1 Trends in mortality in Eastern Europe and the former Soviet Union

There is a sharp divide in mortality between Eastern and Western Europe, which has developed over the past four decades. In 2009 life expectancy was 74.2 years for men and 80.3 years for women in the Czech Republic, and 71.5 years for men and 79.9 years for women in Poland, compared to 77.9 for men and 83.4 for women in EU-15. Despite the recent improvements, life expectancy in Russia is still considerably lower than in Western Europe, with life expectancy at birth of 62.7 years for men and 74.7 for women (Human Mortality Database).

After the Second World War, health improved dramatically across Europe with the spread of antibiotics and the large-scale use of immunization and improvements in infant mortality. In the mid-1960s, all European countries had completed the second stage of the epidemiologic transition and had eradicated infectious mortality, particularly among young children (Barrett et al., 1998). Between 1970 and the end of the 1980s, life expectancy at birth in the former communist CCEE (Czech Republic, Hungary, Poland and Slovakia), Russia and the Baltic states (Estonia, Latvia and Lithuania) stagnated or declined. This led to an increasing gap in life expectancy between East and Western European countries as the latter steadily improved. The anti-alcohol campaign introduced in 1985 by Mikhail Gorbachev was accompanied by a brief increase in life expectancy. Soon afterwards there was a sharp decline induced by the collapse of the Soviet Union in 1991 (White, 1996, Shkolnikov and Nemtsov, 1997, Leon, 2011).

The post-1989 collapse of communist regimes was accompanied by a dramatic rise in mortality rates in many parts of Central and Eastern Europe. People in working-age, particularly men, were hit hard by the mortality crisis of the 1990s, due to violent deaths, accidents and suicides, as well as the rising cardiovascular mortality rates at middle and older ages (Cockerham, 1999, Brainerd and Cutler, 2004, Vallin and Meslé, 2004). Geographically, increased premature mortality was marked in the Western part of the former Soviet Union, including the Baltics, Russia, and Ukraine. On the other hand, in some countries in Central Europe (Czech Republic and Poland), the downturn in longevity during the 1990s was relatively small, and was soon followed by a substantial increases in life expectancy. Improvements in life expectancy in Central Europe were primarily due to reductions in cardiovascular disease and dietary improvements

(Rychtaříková, 2004). Circulatory diseases and external causes of death contributed to the widening of mortality differentials between Central and Eastern Europe and the former Soviet Union since the beginning of the 1990s (Vallin and Meslé, 2004).

Several explanations have been suggested for such differences in mortality: risk factors, such as smoking, alcohol consumption, obesity or diet, blood cholesterol or blood pressure, are suggested to explain part of the East-West health divide (Bobak and Marmot, 1996). In Poland, changes in dietary habits, such as a decrease in the consumption of animal fats and an increase in the consumption of fruits and vegetables, are believed to be among the main determinants of the significant reduction in CVD mortality (Zatonski et al., 1998). Bandosz et al. (2012) have suggested that the recent decline in mortality from coronary heart diseases in Poland can be attributed to changes in cardiovascular risk factors such as reduction in cholesterol levels and an increase in physical activity. Other factors include improvements in the quality of medical interventions. It has also been suggested that socioeconomic circumstances and psychosocial factors play an important role in mortality in CCEE (Bobak and Marmot, 1996, Mackenbach et al., 1999, Laaksonen et al., 2001, Murphy et al., 2006, Vandenheede et al., 2014).

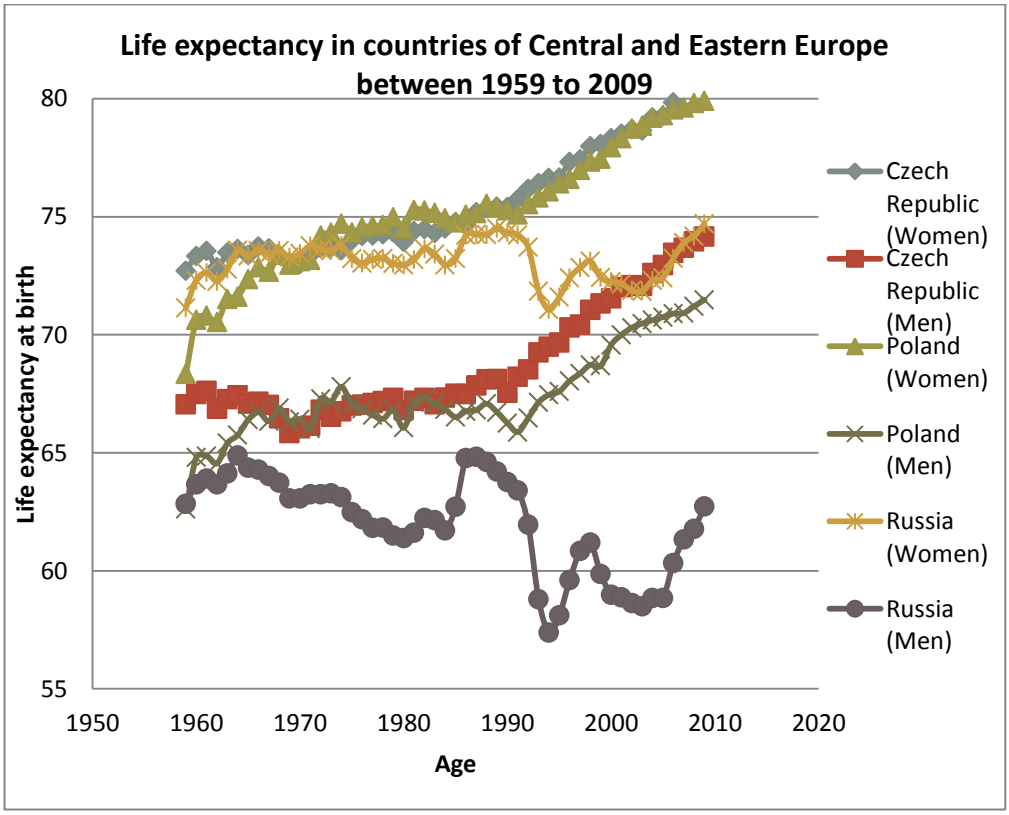


Figure 1 Life expectancy in countries of Central and Eastern Europe between 1959 to 2009.

Source: *Human Mortality Database*. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de

2.2 What is quality of life?

Over the last few decades, quality of life has been studied extensively and a wide range of definitions of quality of life have emerged within health and social science disciplines. However, there is no universally agreed definition of quality of life. Currently, there are only a few agreed aspects of quality of life construct. Overall, researchers agree that the quality of life definition should include subjective component, that is, the individual's perspective of quality of life, and multi-dimensionality. The subjectivity component is characterized by measures of individuals' judgment of their quality of life, such as the satisfaction with life scale (Pavot and Diener, 1993). Another principal aspect of quality of life construct is

multi-dimensionality; this can be seen in instruments such as the World Health Quality of life (WHOQOL) scale, which measures quality of life in terms of four primary dimensions (Physical, Psychological, and Social Functioning, and aspects of the Living Environment), as well as a general rating of overall quality of life and health (WHO Group, 1998).

Quality of life is recognized as a useful construct in a number of social and medical sciences such as sociology, political science, economics, psychology, philosophy, and others. However, different academic disciplines have taken rather different approaches in investigating the construct of quality of life.

Sociologists and political scientists are often interested in the quality of life at the societal or population level, and have focused on objective components of quality of life e.g. income, housing, or education. For example, Johansson (2002) defined quality of life as “The individual’s command over resources in the form of money, possession, knowledge, mental and physical energy, social relations and security, through which the individuals can control and consciously direct their living conditions”. In contrast, psychologists and medical scientist are interested in assessing individual and subjective experiences of a good life such as happiness, life satisfaction and self-worth (Diener et al., 1999).

Lawton (1999) offered a broad definition of quality of life. He called it the “good life” and stated that quality of life is a multidimensional evaluation, which can be represented by both objective and subjective components: behavioural

competence, physical environmental quality, perceived quality of life and psychological well-being.

Similarly, Lane (1996) has defined quality of life as a process which includes both subjective and objective elements. In his approach, quality of life is perceived as the relation between two subjective elements and a set of objective circumstances. The subjective elements of a high quality of life include: 1) a sense of well-being and 2) personal development, learning growth. The objective element includes quality of conditions representing opportunities for exploitation by the individual. He emphasized the active role of personal experience and the capacity of individuals.

Katschnig (1997) defined quality of life as “a loosely related body of work on psychological well-being, social and emotional functioning, health status, functional performance, life satisfaction, social support, and standard of living, whereby normative, objective, and subjective indicators of physical, social and emotional functioning are all used”.

In relation to health, measures of health status, such as the SF-36 questionnaire, is increasingly referred to as quality of life or more often Health-related Quality of life (HRQOL) (Bergner, 1989, Rejeski and Mihalko, 2001, Hickey et al., 2005, Lima et al., 2009, Hawton et al., 2011). HRQOL, like subjective health status, is patient based, but focuses on the impact of disease and treatment on daily functioning and ability to live fulfilling life. From a health perspective, quality of life refers to the social, emotional and physical well-being of patients following

treatment. The World Health Organization Quality of life group has defined quality of life as “an individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns” (WHO Group, 1998)

As can be seen from the above definitions, quality of life is a broad construct that is difficult to measure. Farquhar (1995) states that “Quality of life is a problematic concept as different people value different things”. Schalock (2000) noted that there are over 100 different definitions of quality of life; all of these definitions provide researchers with a general understanding of what quality of life means; however, they do not explain how the various elements can be combined into one operational construct. Furthermore, publications on quality of life from medical literature often do not provide definitions of quality of life. In 1994, Gill and Feinstein reviewed the use of quality of life measures according to specific criteria and found that, investigators defined what they meant by the term quality of life in only 11 (15%) of the 75 articles reviewed, acknowledged the different domains in only 35 papers (47%) and reasons for selecting the chosen quality of life instrument was given in only 27 papers (36%). Also, the investigators did not distinguish overall quality of life from health-related quality of life. More recently, Taillefer et al. (2003) identified that 16 out of 68 Health-related quality of life models assessed did not provide a definition of quality of life. The implication is that researchers often avoid the issues of definition and focus on discussing measures which imply a type of definition.

2.3 Measurement of quality of life in old age

Quality of life in old age is an area which has been relatively under-researched. Garratt et al. (2002) reported that of 3,921 reports on the development and evaluation of patient assessed quality of life tools, only 8% is concerned with quality of life of older people. Several of these measures have been intended for limited use with specific subgroups of older population or focus on the illnesses or diseases that are more frequently in old age. The Short-Form health survey (SF-36), a generic measure of quality of life, was the most widely evaluated measure accounting for over 10% of the total number of reports.

The lack of a theoretically-informed measure of quality of life, particularly in early old age, has led to usage of various proxies, such as health, as measure of quality of life; quality of life in old age is often defined in terms of the ability to perform activities of daily living and fulfil social roles.

Health and functional status are judged to be important dimensions of quality of life, particularly among the elderly because of higher rates of chronic diseases related to ageing. As a result, old age is often conceptualized as an unavoidable time of poverty, and declining physical and mental health. However, there is evidence that people of different age, health status, and residence arrangement may have different priorities when judging their quality of life (Phillipson and Walker, 1986). The experiences of ageing and old age can vary between people across many factors, such as gender, age, and ethnicity; as well as in terms of their health status, their resources, and the environment in which they live and there is heterogeneity across the older population. Consequently, there is a need

for models of quality of life which specifically address particular stages of old age, such as the transition from working to retirement. Many older adults are living longer, active and more fulfilling lives, even in the presence of poor physical health. Strategies to measure quality of life therefore need to take into account of the variability among older adults and should attempt to include more positive dimensions of ageing.

2.4 Two approaches to well-being: hedonic or subjective well-being vs eudaimonic well-being

In the literature the terms quality of life and well-being are often used interchangeably together with other terms such as life satisfaction and happiness, which is regarded by some authors as being an indicator of subjective well-being and of quality of life. Psychological research demonstrated that these are related but conceptually distinct constructs. It is therefore important to clarify distinctions between these constructs.

Research on well-being and quality of life can be thought of as falling into two traditions: hedonism or eudaimonism (Kahneman et al., 1999, Deci and Ryan, 2008). In the hedonistic tradition, the focus is on happiness, generally defined as the presence of positive affect and the absence of negative affect, and an evaluation of life satisfaction; the eudaimonic tradition emphasizes positive psychological functioning and human development. In the literature, hedonic well-being is sometimes equated with subjective well-being, while eudaimonic well-being is sometimes labelled psychological well-being, in order to clearly distinguish between the two concepts (Waterman, 1993, Keyes et al., 2002,

Vanhoutte, 2014).

Hedonic or subjective well-being assumes that through maximizing pleasurable experiences and minimizing suffering, the highest level of well-being can be achieved. Subjective well-being is composed of several components including life satisfaction, the presence of positive affect (pleasant moods and emotions), and an absence of negative affect (unpleasant moods and emotions) (Bradburn, 1969, Diener, 1984, Vanhoutte, 2014). The cognitive component of hedonic well-being is often referred to as life satisfaction as it represents a global cognitive evaluation or judgment of individuals' satisfaction with their life. In contrast, positive affect and negative affect assess the affective component of subjective well-being. Positive and negative affect reflect the amount of pleasant and unpleasant feelings that people experience in their lives. Positive affect is a state whereby individuals feel enthusiastic, active and alert. High positive affect is characterized by high energy, full concentration and pleasurable engagement, while low positive affect encompasses sadness and lethargy. Negative affect generally reflects subjective distress and unpleasant mood states, such as anger, fear and nervousness. Low negative affect includes calmness and serenity.

The eudaimonic tradition of well-being research corresponds to the philosophical theory of eudaimonia (human flourishing), and defines well-being as optimal human functioning and self-realisation. Eudaimonism recognizes that the quality of life is not solely about pleasure and happiness, but involves developing one-self and realizing one's potential. Hedonic well-being is mainly focused on emotional functioning, whereas eudaimonic well-being focuses primarily on

motivational and social aspects of functioning (Figure 2).

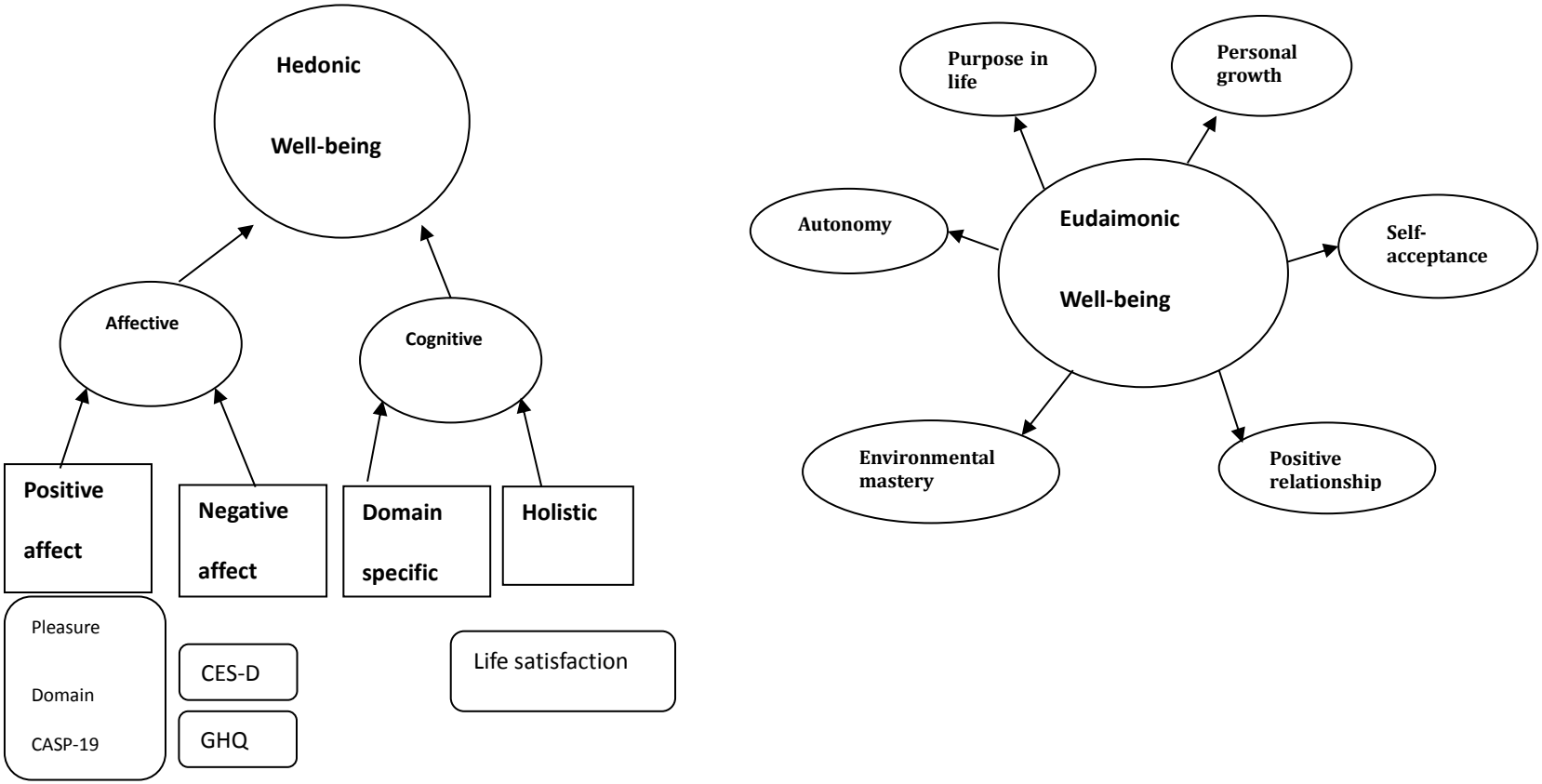


Figure 2 Overview of dimensions of hedonic and eudaimonic well-being

2.5 CASP score: measure of quality of life in early old age

In this thesis, quality of life is measured in terms of the fulfilment of human needs using the CASP instrument. As described in **Chapter 2.4** (Figure 2, page 32), CASP items address several aspects of eudaimonic well-being outlined by Ryff and Keyes (1995). The CASP-19 does not capture the personal growth and positive relationships domains but the control, autonomy, and self-realisation scales correspond to the concepts of environmental mastery, autonomy, self-acceptance, and purpose in life that constitutes psychological well-being in Ryff's taxonomy (e.g “I feel that what happens to me is out of my control”; “I feel that my life has meaning “; “I choose to do things that I have never done before” and “I feel satisfied with the way my life has turned out’”). In some aspects CASP-19 also represents positive affect component of hedonic well-being. Pleasure domain of the CASP-19 partially represent hedonic well-being by measuring enjoyment and happiness (e.g “I enjoy the things that I do”; “I enjoy being in the company of others”; “On balance, I look back on my life with a sense of happiness”; and “I feel full of energy these days”).

CASP-19 is a theoretically based measure of broader quality of life, which has been developed as a reaction to the under-theorized nature of existing quality of life measures. CASP-19 is underpinned by social theories: specifically, Maslow, Doyal and Gough’s theory on human need (Doyal and Gough, 1991, Maslow, 1968), Laslett’s theory of the Third Age (Laslett, 1989); Giddens on reflexivity (Wiggins et al., 2004); and Gilleard and Higgs on cultures of ageing (Gilleard and Higgs, 2000). This scale is specially designed to measure quality of life for adults in the “Third age”. Laslett (1998) has defined Third age as the period between

exit from labour force and the beginning of physical dependency. Fourth age follows later in life when abilities are weakening so that everyday life becomes dependent on others. He recognized old age as time of greatest personal fulfilment as retirement brings opportunities to become active and develop personal interest. Moreover, CASP is intended to be independent of the factors that influence quality of life, such as material circumstances and health. The model comprises four life domains: Control, Autonomy, Self-realisation and Pleasure, mapped on to a single intrinsic measure of quality of life. The lowest score represents a complete absence of quality of life, and the highest score represents total satisfaction across the four domains. Specific details of CASP instrument will be given in the Methods (**Chapter 4.2.2**). This needs satisfaction model assumes that quality of life is not simply the absence of ill-health or about securing basic needs such as food and shelter but also involves engaging in reflexive and active aspects of living. Control is the ability to actively intervene in one's environment, whilst autonomy is defined as the freedom from unwanted interference of others. Self-realisation and pleasure domains capture the active and self-reflexive aspects of living that bring reward and happiness to people in later life (Hyde et al., 2003, Hyde et al., 2015).

2.6 Psychometric properties of CASP scale

CASP-19 has been extensively used in various samples and settings. CASP items have been administered in large population-based samples such as the English Longitudinal study of Ageing (ELSA) (Marmot et al., 2003), the 2004 U.S. Health and Retirement Study (HRS) (Clarke et al., 2007); and the British

Household Panel study (BHPS)(Taylor et al., 2001).

There have been number of studies which have validated the underlying factor structure of CASP-19 (Wiggins et al., 2008, Bowling and Stenner, 2011, Sim et al., 2011, Vanhoutte, 2012, Sexton et al., 2013). Most of the findings on the psychometric properties of CASP-19, however, have been reported among West-European samples, primarily from the United Kingdom (Wiggins et al., 2008, Sim et al., 2011, Bowling and Stenner, 2011) and Ireland (Sexton et al., 2013). Earlier studies on the psychometric properties of CASP have suggested that a four-factor measurement model for the 19-item scale and two or three-factor structure for 12-item CASP scales best fit data. For example, Wiggins et al (2008) has shown that a four-factor measurement model of CASP-19 has a good fit to the data, among the BHPS and ELSA samples in the UK. Also, their results suggested that the shortened three-factor CASP12v2 has superior model fit than the original 19-item scale (Wiggins et al., 2008). These findings have also been confirmed by Sim et al. (2011); the authors assessed the psychometric properties of CASP-19 and CASP12v2 on a sample of 120 British adults living in the retirement community, using the Confirmatory factor analysis (CFA) approach (Sim et al., 2011).

Four more recent studies from outside of the U.K have, however, yielded rather different results. Sexton et al (2013) used the data from The Irish Longitudinal Study of Ageing (TILDA) to undertake a detailed psychometric assessment of CASP-19. Their findings did not support the validity of the established

measurement models. The control and autonomy, self-realisation and pleasure factors were not sufficiently distinctive either empirically or conceptually. Instead they recommended the use of a revised 12-item scale with either a single-factor or two-factor model (CASP12v3) when assessing overall quality of life. Sexton et al. (2013) also found that there is a method effect in the CASP scale and allowing error correlations between negatively worded items led to significant improvement in model fit (Vanhoutte, 2012, Sexton et al., 2013). To date, the psychometric properties of the proposed single or two-factor model using CASP12v3 have not yet been further validated in other studies.

In a study by Wu et al (2013), a Chinese-Taiwan version of the CASP-19 and CASP12v2 were tested and validated. For the 19-item scale, their results showed that the first order five-factor model (CASPP-19), comprising of an additional factor which the authors labelled 'Participation', provided the best fit for the data. For the CASP12v2, first and second-order original models performed equally well.

Most recently, the results from study of psychometric properties of CASP among community-dwelling older adults in Recife, Brazil, demonstrated that a 16-item version of CASP has good internal consistency and a four-factor model is suggested to be the most plausible model of CASP for the Brazilian sample (Lima et al., 2014).

In a study of quality of life among a small sample of older Ethiopian residents, Hamren and colleagues (2014) found that four-factor solution of CASP12v2 results in poor Goodness-fit indices. Alternatively, they found evidence to suggest that 11-item version of CASP is suitable for use with the Ethiopian population(Ha mren et et al., 2014).

These research findings from the literature suggest that psychometric properties of CASP instrument vary according to the sample under study and consequently more cross-national validation of the scale is needed for it to be used across different datasets. Despite the widespread use of the CASP, the instrument has not been subjected to rigorous inspection to determine whether its psychometric properties hold across different national and cultural settings, particularly among Central and Eastern European populations.

2.7 Key predictors of quality of life and CASP

2.7.1 Gender and quality of life

Gender differences are small but persistent when it comes to quality of life. Previous studies have showed small to insignificant gender differences in CASP scores (Wiggins et al., 2004, Netuveli et al., 2006, Zaninotto et al., 2009). Netuveli and colleagues (2006) looked at gender differences in quality of life and found that men reported lower CASP-19 scores than women. Similarly, Zaninotto et al. (2009) reported that there is a significant gender difference in CASP scores, with men having poorer quality of life. On the other hand, Wiggins et al. (2004)

did not find a statistical association between gender and quality of life. The mean CASP-19 scores for men and women were not significantly different ($p<0.62$).

2.7.2 Age and quality of life

Old age is related to psychological and sociological loss as well as declining health, and is perceived to decrease quality of life. However, the results of previous research are mixed and inconsistent.

In recent studies, researchers have reported that the relationship between age and quality of life, measured by happiness or life satisfaction, is non-linear (Helliwell, 2003, Clark and Oswald, 2006, Blanchflower and Oswald, 2008, Van Landeghem, 2009, McCrory et al.). Quality of life is believed to reach its minimum between 30 years of age and early 50s. For instance, in a cross-sectional analysis of 6,100 adults from the first wave of the British Household Panel Survey, Clark and Oswald (2006) found a U-shaped relation between age and 12-item General Health Questionnaire (GHQ) score. Also, Clark et al. (2007) controlled for cohort effects using fixed-effects estimation in fourteen waves of British Household Panel data to investigate whether the U-shaped pattern is caused by cohort effects rather than ageing.

Blanchflower and Oswald (2008) tested the robustness of the U-shaped relation between life satisfaction and age using set a dummy variables for each birth decade to account for cohort effects in a sample of over 500,000 adults from the U.S General Social Surveys, 1972-2006, Eurobarometer Surveys, 1976-2002

and U.K Labour Force Survey, 2004-2007. They concluded that the curved associated between age and life satisfaction holds after inclusion of cohort effects and accounting for effects of various demographic and economic variables. (Blanchflower and Oswald, 2008)

With respect to CASP score, Wiggins et al. (2004) and Netuveli, et al. (2006) have both found significant effects of age on quality of life, when analysed the relationship using cross-sectional data. Wiggins et al. (2004) used a nationally representative sample representative sample of members of the 1930s Boyd-Orr study of health and diet. They found that respondents aged 70 and over have lower quality of life than those that are younger. There was a strong effect of age on CASP- 19, which suggests that quality of life deteriorates with age (Wiggins et al., 2004). Using cross-sectional data from the first wave of the English Longitudinal Study of Ageing (ELSA), Netuveli et al. (2006) found that among non-institutionalized adults, quality of life increases from age 50 to a peak at 68 years, and from there it declines gradually.

Steptoe et al. (2012a) investigated the associations between different dimensions of psychological well-being and various socio-demographic variables using wave 5 data from the English Longitudinal Study of Ageing. In this study, two dimensions of psychological well-being were derived from CASP-19 questionnaire: affective (happiness and enjoyment of life) and eudaimonic well-being (sense of purpose and meaning in life) from CASP-19 questionnaire. Scale of Enjoyment of life was derived using four questions from the CASP-19 1) “I

enjoy the things that I do" 2) "I enjoy being in the company of others" 3) "On balance, I look back on my life with a sense of happiness"; and 4) "I feel full of energy these days". Eudaimonic dimension of well-being was measured using the remaining 15 questions of CASP-19 not included in the enjoyment of life scale. The CASP-derived measure of eudaimonic well-being showed a curvilinear pattern with age, peaking at age 60 to 69 and decreasing sharply in the oldest age group

Zaninotto and colleagues (2009) have also used data from ELSA over three survey waves to predict age trajectories in quality of life, using the CASP-19 questionnaire. Results revealed that quality of life at baseline is poorer for older than younger respondents, and the differences widened with age. CASP-19 also declined more rapidly for older individuals over time.

2.7.3 Socioeconomic position and quality of life.

Netuveli and colleagues (2006) reported that among 8,038 ELSA wave1 participants aged 50 or older, those with no educational qualifications had significantly lower CASP-19 score (40.5, 95%CI 40.2 to 40.8) than those with some form of education (43.7, 95%CI 43.5 to 43.9). In this study, there was also a gradient in CASP-19 scores according to the National Statistics Socio-Economic Classification (NS-SEC), with those in the management occupations having the highest level of CASP-19 scores. The gradient was steeper for income quintile; CASP-19 scores decreased from 45.5 (95% CI 45.2 to 45.8) for the highest quintile to 40.3 (95% CI 39.8 to 40.7) for the lowest quintile. Also, poor

perceived financial circumstances and economic inactivity due to unemployment reduced CASP-19 scores, while owning cars, being on the high end of income distribution, and retirement was related to higher quality of life (Netuveli et al., 2006).

In a study by Blane et al. (2007), CASP-19 has been shown to vary by social position. Social position was measured by the NS-SEC. Among English participants aged 50 to 72 years, highest mean CASP-19 score (45.8) was found in the NS-SEC social class 1 of higher managerial and professional occupations, while the lowest mean CASP-19 score (40.4) was found in the NS-SEC social class 7 of routine occupations. The mean scores were graded with incremental reductions between NS-SEC social classes1 and 7, with difference in mean scores of 5.4 CASP-19 points.

Von dem Knesebeck et al. (2007) examined the association between CASP12v1 and multiple indicators of socioeconomic position among older adults aged 50 using data from the Survey of Health, Ageing and Retirement in Europe (SHARE). Among different indicators of socio-economic position, conventional socio-economic measures (household income, levels of education) as well as car ownership and household net worth were useful in predicting the differential risk of poor quality of life among older people, before (50-64 years) and after retirement age (65 years or older).

Zaninotto et al. (2009) found that not in paid employment and being in the poorest quintile of total wealth have negative impacts on CASP-19 among individuals aged 50 and over from the English Longitudinal Study of Ageing study.

Steptoe et al. (2012a) reported that participants from the higher wealth groups had a greater eudaimonic well-being than those in the lowest wealth group, and there was a clear gradient in the relationship. Eudaimonic well-being showed differences between the lower and highest wealth group of more than 25%; by contrast, the differences for affective well-being (enjoyment of life and positive affect) were less marked.

Two studies have examined how socioeconomic circumstances in early life shape quality of life in old age using a life course approach. In an analysis of French occupational cohort data, Platts and colleagues (2014) have found a significant graded association between occupational grade in 1989 and better quality of life over 16 years of follow-up. However, this relationship was largely explained by more recent life circumstances, such as social status, mental health, wealth, and physical functioning.

Similarly, using data of the Survey of Health, Ageing and Retirement in Europe Wahrendorf and Blane (2014) have demonstrated that, across 13 European countries, deprived childhood circumstances are related to lower quality of life in older ages and that this association is partly mediated through labour market

disadvantage during working life. Circumstances in early life shape individuals' life courses and their employment histories, which in turn can affect quality of life after retirement. Results from these studies support findings from previous study by Webb et al. (2010) which reported that proximate factors, such as depression, perceived financial position and quality of the neighbourhood are more important for quality of life in old age than more distal factors.

2.7.4 Physical health and quality of life

Blane et al. (2008) investigated the association between three objective measures of health (blood pressure for hypertension, lung function for respiratory disease, and body mass index for obesity) and CASP-19 score, using data from the English Longitudinal Study of Ageing (ELSA). They found a positive cross-sectional association at ages over 50 years between lung function and quality of life; and a negative association with body mass index. Blood pressure, in contrast, was not associated with quality of life. The association between lung function and quality of life was found to be mostly indirect via functional limitation and clinical depression; for BMI the indirect effect predominantly was via functional limitation. Longitudinally, change in physiological status had little effect on quality of life.

Netuveli et al. (2006) found that physical health and functioning, have strong influences on quality of life in old. A longstanding illness could reduce CASP-19 by half a unit (regression coefficient of -0.48 95%CI -0.83 to -0.14). If the illness was limiting, the reduction was almost four times larger (-2.06, 95% CI -2.50 to -

1.62). Limitations in physical activities such a mobility and ADL/IADL also reduced quality of life (Netuveli et al., 2006, Zaninotto et al., 2009).

Wikman et al. (2011) investigated the impact of eight different chronic conditions on CASP-19. The study involved 11,523 individuals aged 50 years and older, taking part in wave 1 of the English Longitudinal Study of Ageing. Identification of chronic medical conditions was based on self-report of having been told of the illness by a doctor. There was a significant association between presence of chronic illness and quality of life. Quality of life was reduced for each of the eight chronic illnesses (diabetes, lung disease, asthma, cancer, osteoarthritis, rheumatoid arthritis, CHD, stroke), compared with those not having any condition, adjusting for age, gender, and wealth ($p= 0.005$). Also, a significant linear trend was observed across groups, with CASP-19 scores decreasing from 44.2 (95 CI 44.0–44.4) in the no illness group to 34.78 (95% CI 33.2–36.4) in respondents with four or more co-morbidity conditions.

On the contrary, in a cross-sectional study of 699 Taiwanese older adults, Wu et al. (2014) studied the relationship between CASP-19 and physiological laboratory measurements and lifestyle factors. Contrast to other studies, they found no significant association between CASP and various laboratory measurements, except for anemia. Some self-reported comorbidities such as depression, history of rheumatoid arthritis, Parkinson's disease and malignancy, however, were associated with poor quality of life. Advanced age, blurred vision and central obesity were also associated with a lower CASP-19, while male gender and

regular exercise were related to better quality of life. The findings of this study suggests that poor objective measurements of health may not equate to poor quality of life, rather it is the impact of disease on social functioning that effects quality of life in old age (Wu et al., 2014).

2.7.5 Psychosocial factors and quality of life

Psychosocial factors which have been reported to have positive effect on quality of life include being resident in a neighbourhood perceived to be good, social support defined in terms of the quality and frequency of relationships with family and friends. There is also a strong negative association between depression, assessed by the eight item Center for Epidemiological Studies depression scale, and CASP-19 score (Wiggins et al., 2004, Netuveli et al., 2006, Zaninotto et al., 2009). Moreover, there is a significant association between marital status and CASP. According to Steptoe and colleagues (2012a), married ELSA participants had significantly higher mean eudaimonic well-being, enjoyment of life, and positive affect scores than those who were divorced/separated, widowed or never married.

2.7.6 Behavioural risk factors and quality of life

Zaninotto et al. (2010) examined the association of BMI and waist circumference, with CASP-19 scores. Among older people, for a given BMI, increased waist circumference was associated with higher risk of poor quality of life, whereas increased BMI had a protective effect on quality of life for women.

In a study by Steptoe et al. (2012a), physical activity had a marked association

with CASP-derived measures of psychological well-being. Compared to those who are sedentary, physically active participants had a significantly higher positive affect and eudaimonic well-being. There was only a weak association between CASP-derived eudaimonic well-being and not smoking; no significant relationship was observed between scale of enjoyment of life (derived from CASP) and smoking.

Lang et al. (2007a) investigated the association between smoking and quality of life among 9,176 participants aged 50 years or over who responded to CASP-19 questionnaire as part of the ELSA. There was a dose–response relationship, whereby heavy smokers (those with more pack-years of smoking) have poorer quality of life scores compared to light smokers, and they observed better quality of life in ex-smokers than in current smokers. Ex-smokers had an odds ratio (OR) of 1.03 (95% CI 0.79 to 1.14) and smokers have an OR of 1.47 (95% CI 1.28 to 1.68).

Lang et al. (2007b) used linear regression analysis to estimate the effects of the level of alcohol consumption on subjective well-being, measured by CASP-19. They found evidence of lower levels of well-being in older ELSA participants who abstained from alcohol, compared to those who consumed no more than one drink per day. This was true for both men and women. This indicates that moderate alcohol intake may have some protective benefits for quality of life of older adults.

Likewise, Steptoe et al. (2012a) found participants who drink regularly (5 to 7 days a week) reported higher levels of enjoyment of life, positive affect, and eudaimonic well-being and life satisfaction, compared to those who drink less than five or none at all. However, differences were small.

2.8 Positive well-being, CASP and later-life mortality

In the literature, prospective studies have found that overall quality of life, whether assessed according to the hedonic view of well-being as positive affect or satisfaction with life, or according to the eudaimonic view of well-being such as purpose in life, autonomy or meaning in life, are good predictors of various health outcomes (Ostir et al., 2000, Collins et al., 2008, Rasmussen et al., 2009, Diener and Chan, 2011, Gale et al., 2014).

Life satisfaction is one among a range of concepts that is assumed to reflect hedonic well-being. In a large population study in England, life satisfaction has been shown to be an independent predictor of mortality up to 20 years after baseline (Bowling and Grundy, 2009).

Danner et al. (2001) analysed the emotional content of autobiographical essays of 180 nuns in American School of Sisters of Notre Dame. It was found that happier nuns (those in the upper 25% of the essay writers) lived about 10 years longer than their less happy counterparts (those in the bottom 25%). The nuns all had similar diets, housing, living conditions. As the happiness measure was

collected at early age many decade before death (on average at 22 years old), the study suggested a causal relation between positive emotions and longevity.

Various other concepts of well-being, such as purpose in life and positive affect which are reflected in CASP, were found to be associated with survival in older adults (Boyle et al., 2009, Hill and Turiano, 2014). Hill & Turiano (2014) reported that purpose in life, as indicated by three questions from the Ryff Scales of Psychological Well-Being, is a predictor of mortality across adulthood. Purposeful individuals lived longer than their counterparts during the 14 years after the baseline, even after controlling for other markers of psychological and affective well-being (HR = 0.85; 95% CI 0.78 to 0.93). For every 1-standard deviation increase in purpose score, the risk of dying over the follow-up decreased by around 15%.

Boyle et al. (2009) examined the association of purpose in life with mortality in a sample of 1,238 community-dwelling older persons enrolled in the Rush Memory and Ageing Project and Minority Ageing Research Study. During 5 years of follow-up, greater purpose in life was associated with a substantially decreased risk of death. The hazard rate of a person with a high score (90th percentile) on the purpose in life scale was about 57% of the hazard rate for a person with a low score (10th percentile). This association did not vary by age, gender, education, or race, and the finding persisted even after controlling for several important covariates, such as depressive symptoms, disability, the number of medical conditions, and income.

In a longitudinal study of individuals aged 40 years or older, Wiest et al. (2011) found that both life satisfaction (HR =0.89, 95% CI =0.79 to 1.00, p <0.05,) and positive feelings (HR =0.81, 95% CI = 0.70 to 0.93, p < 0.05) predict mortality, while controlling for socio-economic status variables and physical health. However, this effect diminished when self-rated health and physical activity were additionally included.

In a large representative sample of elderly people in the UK, Steptoe and Wardle (2011) reported that higher levels of positive affect were significantly associated with a higher probability of survival in the five years following the survey. The study categorized respondents into three groups based on the positive affect they reported over a 24-hour period and then their mortality rates over the follow-up period were compared. Mortality rates among respondents in the highest positive affect category were reduced by 35% on average compared to those in the lowest positive affect category. This rate remained significant even when controlling for demographic factors as well as health behaviours, self-reported health, and other conditions. Those in the high and medium positive affect groups had death rates of 3.6% and 4.6%, respectively, compared to 7.3% for the low positive affect group.

Chida & Steptoe (2008) showed, in their quantitative review of studies on psychological well-being and mortality, that positive affect was associated with

mortality in both healthy and ill populations (combined HR=0.82 (95% CI 0.76 to 0.89) for healthy and 0.98 (95% CI 0.95 to 1.00) for ill populations).

In an analysis of 4,411 participants aged 61 years or older, who were recruited as part of the population-based Rotterdam Study (1997–2007), Krijthe and colleagues (2011) found that greater positive affect is associated with lower mortality independently of baseline health. In the age stratified analyses, positive affect independently predicted survival in those below the age of 80 (Hazard ratio = 0.96; 95% CI 0.93 to 0.99) but not in those aged 80 and over in fully adjusted models (Hazard ratio = 1.00; 95% CI 0.96 to1.04). These results suggest that in the oldest age group, perception of positive affect is more likely to be strongly determined by health at baseline.

Perceived control has been shown to be a good predictor of health and mortality. In a random sample of 2,087 adults aged 65 and older from the Australian Longitudinal study of Ageing, perceived control was associated with longevity after controlling for age, and physical function (Anstey et al., 2002).

There is extensive literature documenting the influence of HRQOL on health and mortality. These studies were often conducted in specific samples of older adults, such as those suffering from specific chronic diseases e.g chronic kidney disease (Mapes et al., 2003), liver disease (Kanwal et al., 2009), lung cancer, type 2 diabetes (Kleefstra et al., 2008), ischemic heart disease, heart failure or those

living in settings other than the community such as residents of veteran homes (Kao et al., 2005). For example, a poor HRQOL assessed by using the SF-36, which is a proxy measure of health status, was shown to predict mortality among community-dwelling older adults in Spanish and Taiwanese samples (Tsai et al., 2007, Otero-Rodríguez et al., 2010).

Masel et al (2010) reported that the physical component of HRQOL using SF-36 predicted mortality independently of frailty and other covariates among Mexican Americans.

In an Italian longitudinal study, Health-related Quality of life, as measured by the EQ-5D, independently predicted both mortality and hospitalization after controlling for several demographic and medical covariates (Cavrini et al., 2012)

The association between CASP wand mortality is less well documented. Studies of CASP have mainly focused on its determinants, whilst studies of its association with health outcomes, including mortality, are scarce. Llewellyn et al. (2008) investigated the association between psychological well-being and levels of cognitive function. Psychological well-being as measured by CASP-19 was significantly associated with cognitive functioning after adjustment for depressive symptoms and socio-demographic factors (Lowest to highest CASP-19 quintile: $\beta \geq 0.10$, 95% CI 0.04 to 0.15, $P \leq 0.001$). This association was attenuated though remained significant after additional adjustment for physical health and health

behaviours (lowest to highest CASP-19 quintile: $\beta \geq 0.07$, 95% CI 0.01–0.13, $P \leq 0.014$).

Craigs et al (2009) evaluated the effect of psychosocial status on mortality risk among non-institutionalized older adults in England using data from wave 1 of ELSA. The mean CASP-19 scores for participants who were identified as alive compared with participants who had died was 3.75 and 6.02 respectively, $p<0.0001$. Logistic regression analyses revealed that, after controlling for demographics, health, and lifestyle factors, CASP-19 remained significant predictors of death at end of follow-up (OR=1.10, 95% CI 1.07 to 1.13).

In another study, enjoyment of life, as assessed with the pleasure domain of the CASP-19, was associated with lower risk of death over a 7-year period, independently of covariates (Steptoe and Wardle, 2012). Participants in the highest quartile of enjoyment had a 57% reduction in risk of death. This association attenuated after adjustment for demographic characteristics, health indicators, depression, and health behaviours but was still statistically significant with a hazard ratio of 0.72.

In more recently published paper, Netuveli et al. (2012) used data from the British Household Panel Survey data (2001-2006) to investigate prospectively whether CASP-19 predicts all-cause mortality, during the 5-year follow up period. Compared with a mortality of 12/1000 person-years in those having average CASP-19 score those with below-average CASP-19 score had more than twice

higher (27/1000 person-years) and those above average had a third lower (8/1000 person-years) mortality. This gradient persisted when age and sex strata were examined separately and when models were adjusted for covariates such as self-rated health, socioeconomic variables, and long-limiting illness.

2.8.1 Mechanisms underlying the association between CASP and mortality

Authors of the aforementioned studies have provided several explanations for the observed relationship between CASP and mortality (Netuveli et al., 2012, Steptoe and Wardle, 2012). First, the observed association may be an artefact due to unknown confounding variables. Second, the association may be a selection effect: the factors that ensure survival are also the same influences that contribute to quality of life e.g material circumstances and health, so those with high CASP scores have smaller probability of mortality. Third, there are several potential pathways linking CASP to mortality in later life. Positive affect and purpose of life are elements of quality of life captured by CASP; the pleasure domain on the CASP-19 partially account for positive affect by measuring enjoyment and happiness. Positive affect and life satisfaction are known to be associated with protective psychosocial and behavioural factors such as greater social connectedness, perceived social support, optimism, and adaptive coping responses, as well as a greater probability of engaging in health behaviours such as sensible diet, regular exercise and, not smoking (Grant et al., 2009, Steptoe et al., 2009). These may in turn have protective effects on longevity.

Moreover, quality of life is known to be directly associated with physiological processes underlying health and illness. There is accumulating evidence that having greater quality of life helps effective functioning of multiple biological reactions. Psychological well-being may directly enhance the functioning of neuroendocrine, immune, and cardiovascular systems (Steptoe et al., 2005, Friedman et al., 2007, Marsland et al., 2007, Steptoe et al., 2008, Steptoe et al., 2009) or indirectly by buffering the effects of stress (Pressman and Cohen, 2005, Cohen and Pressman, 2006).

For instance, Ryff et al (2004) investigated the associations of six domains of well-being, with neuroendocrine, inflammatory, and cardiovascular biomarkers in women aged 65 years or more. There were significant associations between purpose life and neuroendocrine and immune markers including salivary cortisol and pro-inflammatory cytokine Interleukin-6, particularly among those aged 75 years or older. In this study, purpose in life has also been found to be positively correlated with high-density lipoprotein cholesterol and negatively with, waist hip ratios, and body weight.

Steptoe et al (2005) found significant association between positive affect and neuroendocrine, inflammatory, and cardiovascular activity in middle aged men and women.

Moreover, Friedman et al. (2007) showed that plasma IL-6 levels were lower

among women who scored higher on positive relationships; in contrast soluble IL-6 receptor (sIL-6R) levels were lower in women with higher purpose in life scores, even after controlling for a variety of socio-demographic and health variables. Also, cortisol levels have been consistently shown to be lower among individuals reporting higher positive affect, and favourable associations with heart rate and blood pressure have also been reported (Lai et al., 2005, Ong and Allaire, 2005, Steptoe et al., 2005, Steptoe et al., 2009).

In another study, Steptoe et al (2008) assessed associations between positive affect, cortisol sampled over the day, and inflammatory markers (C-reactive protein and interleukin-6) among members of the Whitehall II study. Among women, plasma interleukin-6 was also inversely related to positive affect. Neither of the inflammatory markers was related to positive affect in men.

In relation to CASP scale, Netuveli et al. (2012) found that low CASP-19 scores are associated with high levels of C-reactive protein in a sample of older adults from the English Longitudinal Study of Ageing. Elevated levels of interleukin-6 and C-reactive protein have been linked to increased risk of cardiovascular disease, disability and all-cause mortality in older adults (Harris et al., 1999, Ferrucci et al., 1999, Kaptoge et al., 2010, Sung et al., 2014). These findings contrast with those of Wu et al (2014), who found no significant association between CASP-19 and physiological laboratory measurements, except for anemia, among a sample of community dwelling older people in Taiwan. Therefore evidence so far is inconclusive with regards to whether biological

mechanisms mediate the relation between CASP and mortality.

In addition, CASP may affect survival indirectly through healthy lifestyle and health behaviours that reduce long-term risk of disease development. Studies have shown that happier individuals are less likely to engage in harmful and unhealthy behaviours, such as smoking, unhealthy eating and abuse of alcohol (Piqueras et al., 2011).

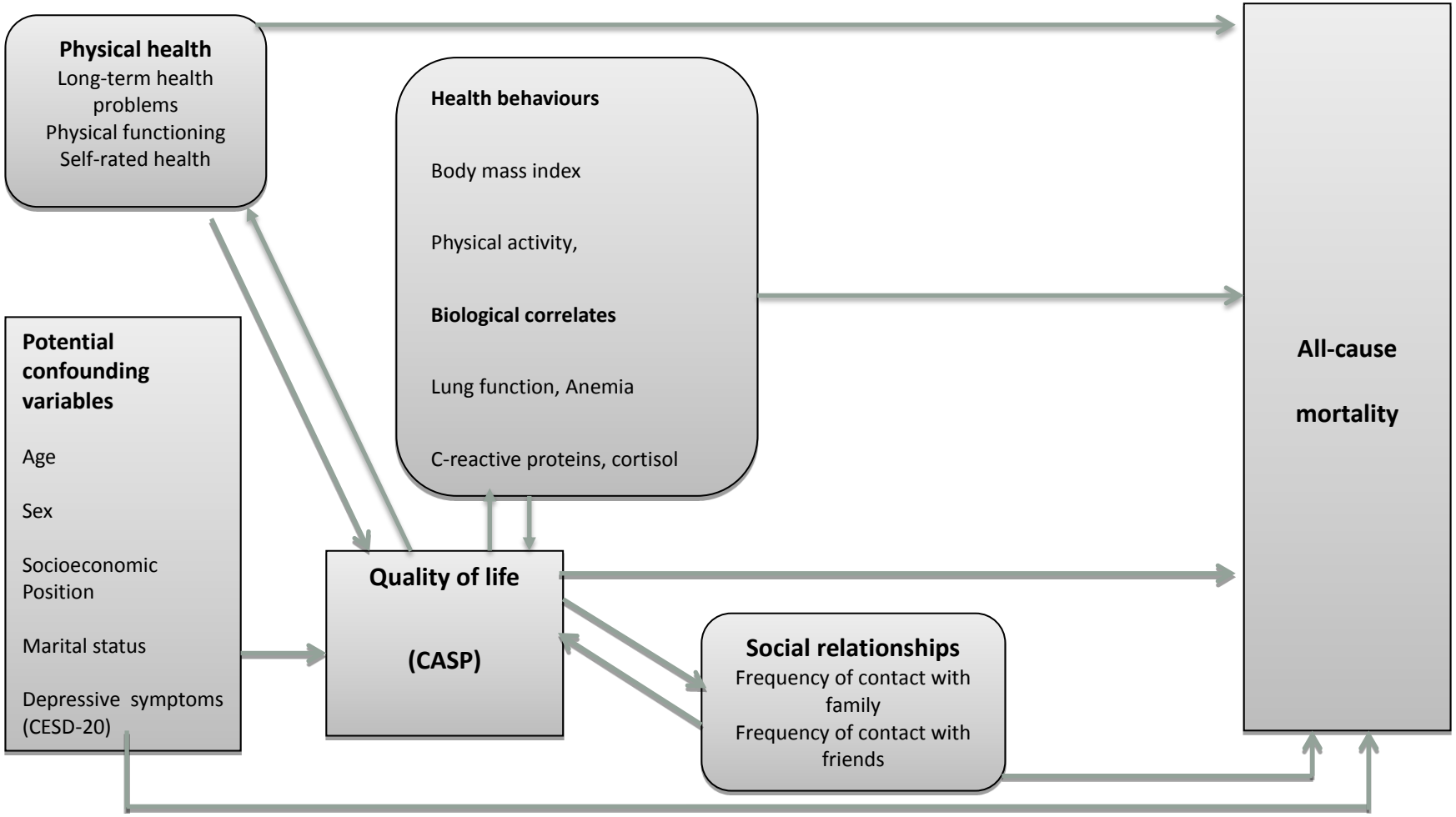
As mentioned earlier, CASP score is positively associated with moderate amounts of alcohol consumption and physical activity (Lang et al., 2007b, Steptoe et al 2012a). The association between CASP score and health-promoting behaviour is likely to be bidirectional and this may partly account for the relationship between positive quality of life and mortality.

Another pathway through which quality of life may affect survival is through social support. Epidemiological studies indicate that individuals with low levels of social support have higher mortality rates (Brummett et al., 2001, Lochner et al., 2003, Rutledge et al., 2004). Quality of life can lead to more positive and fulfilling social relationships; having these relationships may influence the onset or progression of illness through cardiovascular, immune, and the neuroendocrine system (Uchino et al., 1996, Uchino, 2006). Thus, not only is there a direct biological path from higher quality of life to disease risk and mortality, but quality of life is also associated with health-compromising behaviours as well as psychosocial factors

that can exacerbate health status, which may subsequently lead to increased risk for mortality.

A theoretical conceptual model for the hypothesized relationship between CASP and mortality based on the literature on CASP and the possible mechanisms reviewed in **Chapter in 2.8** is illustrated in Figure 3. This model shows that age, sex, marital status, SEP and depressive symptoms are the key covariates which influence older people's quality of life and mortality. Quality of life in old age may influence the probability for survival directly, or indirectly, via influences of various mediating variables. Lower baseline CASP scores may reflect a more severe burden of disease, for example lower quality of life may contribute to declines in physical health, which in turn, lead to higher mortality risk. Furthermore, CASP score is also associated with behavioural risk factors and biological mechanisms. There is also a bi-directional relationship between CASP and social relationship variables. These factors may explain a substantial proportion of the link between CASP and all-cause mortality.

Figure 3 Theoretical conceptual model of possible relationship between mortality and CASP



2.9 Summary of literature and gaps identified

There is no general consensus regarding the definition and optimal measure of quality of life and it remains an ill-defined concept. Old age is related to multiple psycho-social losses and declining physiological functions. As such, generic population constructs of well-being such as happiness, life satisfaction and measures of health status have often used as proxies for quality of life in old age. Although the generic, popular measures of life quality are helpful, their limitations in the context of older people's experience are variously known such as weak theoretical foundation and uncertain psychometric properties. CASP-19 is an alternative quality of life measure, which is specifically designed for the older age group. This quality of life construct has a strong underpinning and it aims to capture positive aspects of life at older ages.

As described in the literature review, currently some empirical investigations have used CASP to identify its predictors in later life; it has been found that indicators of socio-economic position, social connections and everyday competence (primarily the absence of problems with activities of daily living) are important for maintaining a sense of well-being in older ages. Furthermore, it has also been suggested that health behavioural risk factors such as smoking and physical are predictor of CASP-19. Both cross-sectional and longitudinal studies show that quality of life linearly decreases with age, while the cross-sectional study also has shown that it changes non-linearly with age. Thus the shape of the relationship between age and CASP is as yet undecided. Furthermore, most of the empirical literature on the determinants and psychometric properties of CASP concentrates on the data from United Kingdom and evidence from other part of the world, including Central and Eastern European countries, is still limited. Additional deficit

in the existing literature is that there is limited information available on the predictive value of quality of life in a sample of older individuals not selected on the basis of specific disease; nor are there any studies evaluating the association between positive quality of life (CASP) and later-life mortality using population samples different from original sample with which the CASP scale was originally developed.

Overall, there is growing evidence that there are marked associations between positive psychological well-being and health outcomes, including reduced risk of cardiovascular disease, increased immunity and prolonged survival. This relationship appears to hold across a broad spectrum of quality of life measures that have been used to represent positive quality of life, including CASP. However, there have been remarkably few attempts to determine the possible causal mechanisms underlying this relationship. Recent cross-cultural research has documented that numerous behavioural risk factors, including smoking, alcohol consumption and regular physical exercise are potentially associated with positive psychological wellbeing. At the biological level, cortisol level has been consistently shown to be lower among individuals reporting good psychological well-being, and favorable association with inflammatory biomarkers such as interleukin-6 has also been described. Importantly, these relationships were independent of negative emotions, including depression, suggesting that positive psychological well-being may have distinctive biological correlates that can benefit health and survival. Also, protective psychosocial factors such as greater social support have been shown to be associated with positive psychological well-being. Positive psychological well-being may represent a broader profile of psychosocial resilience that reduces the risk of adverse health outcomes. At

present, there has not been any investigation on the possible mechanisms linking CASP to mortality.

The Health, Alcohol and Psychosocial factors In Eastern Europe (HAPPIE) study presents a unique comparable database on quality of life among older adults for Central and Eastern European countries, where studies on quality of life are still in their initial phases, and, as such is one of few such sources of data on CASP in the region. This thesis is original in validating the psychometric properties of CASP for use amongst older adults living in CCEE, as well as being one of the first studies to assess the relationship between mortality and quality of life of retired older adults from CCEE, countries undergoing rapid societal and economic transformation.

Chapter 3

Aim and Objectives

This chapter introduces the overall aim of the thesis: to describe the relationship between all-cause mortality and quality of life in early old age. It also outlines the thesis' objectives and hypotheses.

3.1 Aim of the thesis

The main aim of this PhD is to investigate the ability of baseline CASP score to predict subsequent mortality using data from the prospective multi-centre population-based HAPIEE (Health, Alcohol and Psychosocial factors in Eastern Europe) study in three countries: Czech Republic, Russia and Poland. Furthermore, this project aims to explore the possible causal mechanisms linking CASP and mortality. In order to fulfil these main study aims, the psychometric properties of the various CASP instruments in HAPIEE are being evaluated first because previous validation studies of the CASP have illustrated that the psychometric properties of CASP can vary across countries and datasets. Additionally, the project aims to investigate the association between sociodemographic, psychosocial, and behavioural variables and quality of life in early old age as assessed by the validated CASP scale.

3.2 Objectives

The main objectives for this PhD project:

1) To confirm whether the significant relationship between CASP and mortality found to exist in English cohorts is also relevant to the HAPIEE populations.

To achieve this objective, I investigated the prognostic value of CASP12v3 score for mortality, controlling for other covariates in samples of retired adults aged 50 or over in the HAPIEE cohort.

2) To examine the underlying causal pathways linking quality of life in early old age to subsequent mortality.

   Although mediation analysis serves as a promising framework to study and understand CASP-associated variance in mortality, it has, to date, received limited empirical attention. Accordingly, the second study objective was to elucidate direct and indirect pathways linking CASP to mortality using a structural equation modeling approach. Specifically, I examined the direct impact of CASP on mortality, controlling for age, sex, and relevant socio-demographic variables (i.e marital status and socioeconomic position variables) and depressive symptoms, as well as exploring whether individual's physical health, social relationship with family and with friends, and health behaviours (physical activity and obesity) significantly mediate the relation between CASP and mortality.

Subsidiary objectives

The thesis has two subsidiary objectives including:

3) To establish the validity of CASP for assessing quality of life in a sample of older adults aged 50 to 70 in HAPIEE.

   As reviewed in **Chapter 2.8**, CASP has been used in several national surveys. However, the psychometric properties of this instrument for use amongst Central and Eastern populations are not yet known. Such an assessment is important, as concepts of perceived quality of life may

vary widely across culture or national context. In response to this, I assessed the psychometric properties of the original CASP-19 and three 12-item versions of CASP, in terms of scale reliability and construct validity. Confirmatory Factor analyses were also conducted to test the underlying factor structure of CASP.

4) To identify which factors are associated with improvements or worsening of quality of life in early old age using the version of CASP validated for use across the HAPIEE population.

   I explored whether factors that have been shown in the research literature to be associated with quality of life in other cohorts are also related to quality of life in the HAPIEE cohort. Specifically, I investigated differentials in CASP12v3 scores by socioeconomic factors among people aged 50 years and over, as well as the role of age, behavioural risk factors (physical activity, body mass index), physical health variables, depressive symptoms and social relationship variables in improving or reducing quality of life.

3.3 Hypotheses

Several hypotheses related to above study objectives have been listed:

It was hypothesized that

1.1 There is a graded relationship between quality of life in early old age and risk for mortality, independent of other relevant covariates. The highest tertile of CASP12v3 score is associated with lower risk for mortality.

2.1 CASP has a direct influence on the risk for mortality, after controlling for the effects of age, gender, socioeconomic position, marital status and depressive symptoms.

2.2 Higher CASP scores have a negative indirect effect on mortality partially mediated through self-reported physical health, behavioural risk factors (physical activity, obesity), and social relationship variables, namely, frequency of contact with family and with friends. The level of quality of life measured at baseline would be related to each of these mediators, which in turn, would affect the risk for mortality. CASP will also have a direct effect on mortality risk in addition to its effect through intervening variables.

Hypotheses for subsidiary objectives:

3.1 The 12-item versions of CASP have better psychometric properties than the original CASP-19 in HAPIEE. Specifically, two-factor or three-factor measurement models of 12-item versions of CASP will better fit the HAPIEE data than the four-factor model using the original CASP-19. 12-item versions of CASP will also demonstrate high internal consistency

4.1 There is a positive association between socioeconomic position and quality of life. Education and higher household amenities scores are

associated with better quality of life. Economic inactivity and material deprivation are negatively associated with CASP scores.

4.2 There is a curvilinear relationship between age and CASP. Quality of life increases beyond the age of 50 years, then declines amongst the oldest old.

4.3 Poor self-rated health, physical function, presence of long-term health problems, and depressive symptoms are associated with lower CASP scores.

4.4 Lower levels of physical activity and increases in BMI are negatively associated with quality of life.

4.5 Relationships with friends and family are positively associated with CASP score.

Chapter 4

Methods

This chapter outlines the data, variables and analysis strategies which were used for this thesis. The first part of the chapter, introduces the HAPIEE dataset. The details of the baseline data collection will be described. The next section describes the variables that were used in the analyses. These include the main outcome measure, all-cause mortality and the main study variable quality of life, CASP-19 and a range of socio-demographic variables. The sections that follow describe the statistical analyses which were performed for each of the study objectives.

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4.1 Study population and description of data

The HAPIEE (Health, Alcohol and Psychosocial factors in Eastern Europe) is a multi-centre cohort study that assesses the effects of dietary factors, alcohol consumption, socioeconomic and psychosocial factors on health of men and women aged 45-69 years living in Novosibirsk (Russia), Krakow (Poland), six centres in the Czech Republic (Havirov/Karivina, Hradec Kralove, Jihlava, Kromeriz, Liberec and Usti nad Labem). The study was set up to investigate the determinants of mortality, cardiovascular diseases and other chronic conditions in countries of Central and Eastern Europe and former Soviet Union countries undergoing rapid social and economic transition (Peasey et al., 2006).

The analyses in this project used the baseline data (wave 1), which was collected between 2002 and 2005. A total of 28,945 men and women who were born

between 1933 and 1957, aged 45-69 at baseline, were recruited and stratified by gender and 5 year age groups. The cohorts were randomly selected from population/electoral registers. In Krakow and towns of the Czech Republic, participants were first visited at home to complete the questionnaire and then invited to a clinic for examination while in Novosibirsk, both the questionnaires and examinations have been completed in a clinic.

At baseline (wave 1), all participants completed a structured questionnaire which included information on health (Self-rated health status, medical history, health behaviours, physical functioning (from the SF-36); food frequency questionnaire, socioeconomic circumstances (own and parental education, economic status, type of employment, car ownership and ownership of other household goods; psychosocial factors such as perceived control and the 20 item CESD scale of depression. Working and retired participants also completed additional modules. Working individuals (approximately 50% working) answered a module on working characteristic, which included psychosocial environment at work such as job demand and job control, whilst retired participants who reported receiving pension were administered the retirement questionnaire, which included questions on quality of life (CASP-19). The reliability of local version of the questionnaires was assessed by back-translation into English.

4.2 Description of the analytical sample

The project analysed data from cohorts set up in three countries. As mentioned above, in total, 28,945 individuals were recruited at baseline between 2002 and 2005, with an overall response rate of 59%. The response rates were 61% in Novosibirsk and Krakow, giving an overall sample size of 9,363 and 10,728

respectively; and 55% in six Czech towns with a resulting sample size of 8,856 participants. Altogether, there were 14,060 eligible retired participants, who completed the retirement questionnaire including the quality of life (CASP-19) questions (4,287 Czechs, 3,898 Russians and 5,875 Poles).

A number of individuals were excluded from the final analysis. First, 369 retired individuals who were younger than 50 years old were excluded. The precise age limit for the “Third age” is unknown, but on most accounts it would include the age range 50 to 74 years (Blane et al 2007). Second, those who had missing values across the 19 CASP items were excluded (N=1,330). There were 13,691 participants aged 50 or over who responded to CASP questionnaire: 4,221 (Czech Republic), 3,813 (Russia) and 5,657 (Poland). Of these, only 12,361 subjects (87.9% of those eligible for the CASP-19 measurement) provided responses for all 19 questionnaire items. Also, 427 retirees receiving ill-health pensions were excluded from analyses. This information was available for the Czech data only. After the exclusion, a total of 11,934 participants were available for the final analyses (2,816 Czechs, 3,811 Russians, and 5,307 Poles). Figure 4 shows the final number of participants used for analysis.

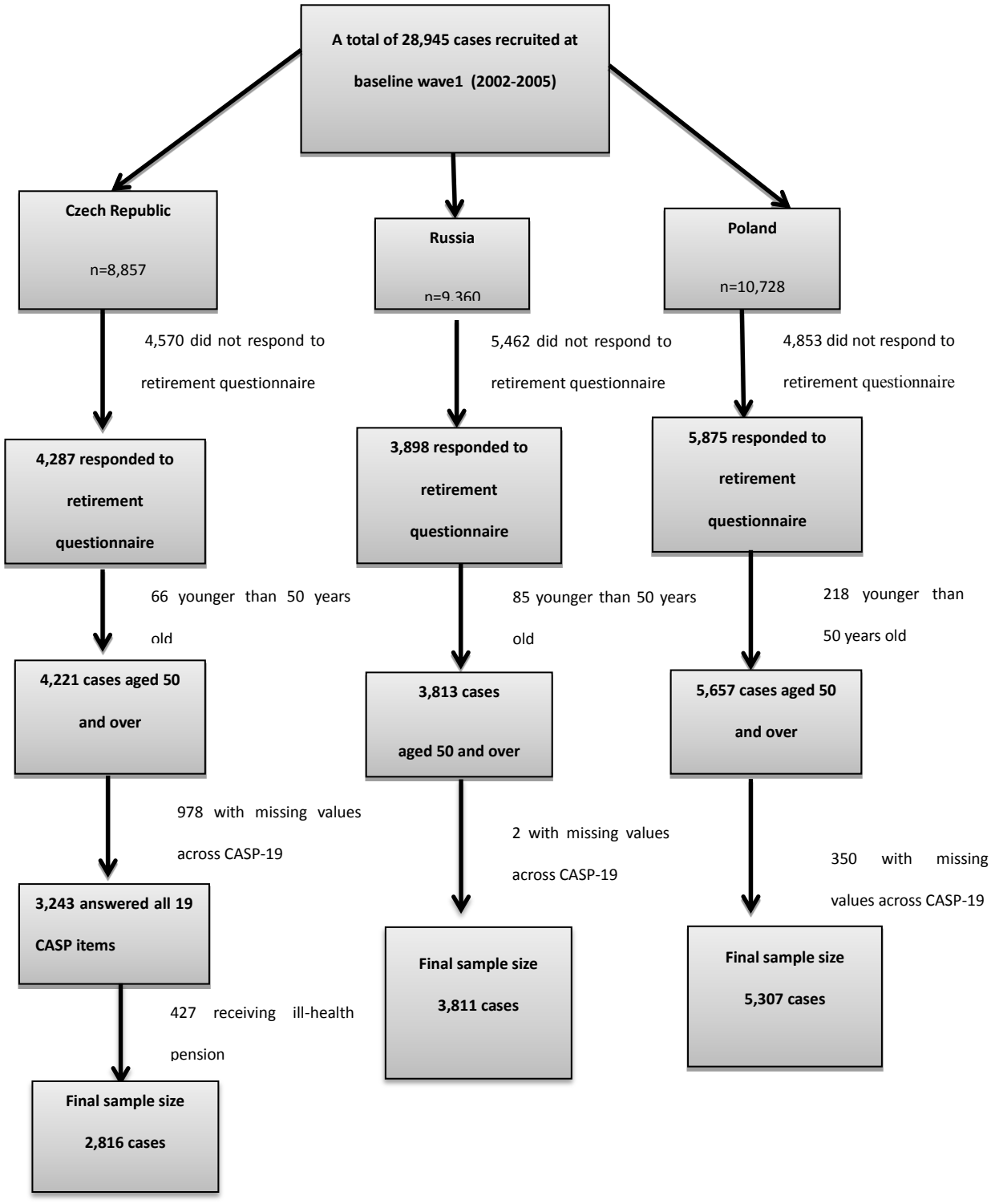

Figure 4 Flow chart showing the number of participants presented for analysis

Variables used for data analysis are described in detail below.

4.2.1 Mortality

The main outcome variable was all-cause mortality. Deaths in the three cohorts were ascertained using local death registers in Krakow and Novosibirsk and national death register in the Czech Republic. For the Czech Republic, mortality was followed until the end of 2011, for Russia until the end of 2010 and for Poland until 2009. In the analyses investigating the relationship between all-cause mortality and baseline CASP score, individuals whose mortality data could not be linked to the baseline questionnaire due to missing national ID number or refusal to be followed up (n = 458) were additionally excluded from the analytic sample. Thus the final analytical sample comprised 11,476 individuals (Czech Republic n= 2,742; Russia n= 3,804 and Poland n=4,930).

The mortality rates were calculated as the number of total deaths recorded during the follow-up divided by the total number of person-years at risk.

4.2.2 Quality of life

CASP-19 & three 12-item versions of CASP-19

CASP is a self-completed quality of life scale, comprising 19 Likert scale items capturing four dimensions of quality of life at older ages: Control, Autonomy, Self-realisation, and Pleasure. Respondents were asked to evaluate how often they feel a particular way about their life, ranging from often to never. Statements are a mixture of positive and negative, with positive items reverse coded so that a higher score equates with higher quality of life. Each item is scored from 0 to 3, with the summed scale ranging from 0 to 57.

There are also three 12-item versions of the original CASP-19: CASP12v.1, CASP12v.2, and CASP12v.3. The CASP-12 is a shorter version of the 19-item CASP score. It comprises 12 items that measure Control, Autonomy, Self-realisation, and Pleasure. There scales are derived from the original CASP-19 by removing items which correlated most weakly with other items in their dimensions. Item wording for the CASP-19 questionnaire and 12 item versions of CASP scale are illustrated in the table below (see table 1).

Table 1 Item wording for CASP-19 and three 12-item versions of CASP

(Often =3, Not Often=2, Sometimes =1, and Never=0)			CASP-19	CASP12v1	CASP12v2	CASP12v3
Control	C1	My age prevents me from doing the things I would like to do	✓	✓	✓	✓
	C2	I feel that what happens to me is out of my control	✓	✓	✓	✓
	C3	I feel free to plan for the future.	✓			✓
	C4	I feel left out of things.	✓	✓	✓	✓
Autonomy	A5	I can do the things that I want to do.	✓	✓	✓	
	A6	Family responsibilities prevent from doing what I want to do.	✓	✓		
	A7	I feel that I can please myself what I can do.	✓		✓	✓
	A8	My health stops me from doing the things I want to do.	✓			✓
	A9	Shortage of money stops me from doing the things I want to do.	✓	✓	✓	✓
Pleasure	P10	I look forward to each day	✓	✓	✓	✓
	P11	I feel that my life has meaning	✓	✓	✓	✓
	P12	I enjoy the things that I do	✓		✓	
	P13	I enjoy being in the company of others	✓			✓
	P14	On balance I look back on my life with a sense of happiness	✓			
Self-realisation	S15	I feel full of energy these days	✓	✓	✓	
	S16	I choose to do things I have never done before	✓	✓		
	S17	I feel satisfied with the way my life has turned out	✓			✓
	S18	I feel that life is full of opportunities	✓	✓	✓	✓
	S19	I feel that the future looks good for me	✓	✓	✓	

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4.2.3 Demographic and socioeconomic position measures

Sociodemographic and socioeconomic position variables considered in this study were age (continuous) and for the purpose of descriptive statistics age was also classified into 5-year age groups 50-54, 55-59, 60-64, 65-69, 70-74; gender, marital status (divided into married/cohabiting, single, divorced and widowed categories).

Educational attainment level

Participants were categorised according to their highest attained education level, which was coded primary, vocational, secondary, and university.

Household amenities score

Household amenities score was assessed based on ownership of the following items: microwave, video recorder, colour television, washing machine, dishwasher, car, freezer, cottage for holidays or weekends, camcorder, satellite or cable TV, telephone and mobile phone. The 12 items were summed to produce a total score ranging from 0 to 24 (coded 0= No, I can't afford it; 1= No, I don't want it; 2=Yes). From the total household amenities score, country-specific tertiles were calculated (Czech Republic 0= 0 to 5; 1=6 to 7; 2= 8 to 12; Russia 0= 0 to 4; 1= 5; 2= 7 to12; Poland 0=0 to 5; 1=6 to 7; 2= 7 to 12). On the basis of tertiles, low household amenity level was coded 0, while medium and high levels were, respectively, coded 1 and 2.

Material deprivation

Level of material deprivation was assessed by three questions about the frequency of difficulties in 1) paying bills, 2) buying food and 3) clothes necessary

for themselves and/or the family. The answers were coded: 0=Never or rarely, 1=Sometimes, 2=Often 3= Always; the total deprivation score was calculated as the sum of the three questions, and categorized into three groups: low (0), medium (1–6), and high (7–9).

Employment status

Employment status of participants was dichotomized into: 1) Working (employed, owner of a company or self-employed, housewife or farmer) or 2) Non-working (employed pensioner, not employed pensioner and unemployed).

Years in retirement

Participants were asked at what age they retired and a variable representing the number of year in retirement was derived from it.

4.2.4 Behavioural risk factors

Behavioural risk factors such as tobacco smoking, participation in physical activity, or body mass index were used.

Smoking

Participants were classified into three smoking groups: never smoker, past smokers, and current smokers

Body mass index (BMI)

BMI is defined as weight (kg)/height^2 (m^2). BMI was used as either a continuous or a categorical variable and the participants were allocated to four groups: underweight (BMI < 20 kg/m2); normal weight (BMI 20.0-24.9 kg/m2); overweight (BMI 25.0-29.9 kg/m2); obese (BMI <30.0).

Physical activity

Participants were asked to state approximately how many hours per week they engage in sports, games, hiking.

4.2.5 Physical and mental health variables

Long-term illness

Participants were asked if they experienced any long-term health problems for which medical treatment has been sought over the last 12 months using a single yes or no item (0= No, 1=Yes).

Self-rated physical health

Self-rated physical health was assessed by the question "How would you rate your health in the last 12 months? with five possible answers: "very good", "good", "average", "poor" and "very poor". For the present analyses, these responses were grouped into three categories (Very good and good, average, and poor and very poor).

Physical functioning

Physical functioning was measured by a 10-question scale from the Short Form 36 (SF36) Health Survey. The questions assessed limitations in vigorous and moderate individual activities, lifting and carrying, bending, kneeling and stooping, walking, climbing stairs, bathing and dressing. Answers to each question were scored from 0 (limited a lot), 1 (limited a little) to 2 (not limited) and summed up to give final scores ranging from 0 to 20 points. The score was additionally multiplied by 5, resulting in a final score ranging from 0 (maximum limitations) to 100 (no limitations). The score was then split into approximate tertiles within countries. Country-specific tertiles were as follows: Czech Republic 0= 0 to 75;

1= 76 to 90; 2= 91 to 100; Russia 0= 0 to 70; 1= 71 to 90; 2= 91 to 100; Poland 0=0 to 70; 1=71 to 90; 2= 91 to 100.

Depressive symptoms

Respondents with depressive symptoms were identified using the Center for Epidemiological Studies Depression (CESD) scale. This instrument comprises 20 questions on how frequently in the past week the participant has experienced range of psychological and some physical symptoms. Responses (range 0 to 3) were summed up to make score with range 0-60, and subjects with a score of 16 and above were classified as having depressive symptoms.

4.2.6 Social networks variables

Variable regarding frequency of contacts with family was categorized as 0=No relatives, 1=Less than once a month, 2= Once a month or more 3= Once a week or more; same coding was used for frequency of contact with friends.

4.3 Strategy of analysis

The purpose of the statistical analysis was to characterize the samples in terms of CASP scores, demographic, socioeconomic and psychosocial factors, in order to examine differences in mean CASP scores between populations as well as to identify associations between explanatory variables and study outcome.

4.3.1 Descriptive characteristics of study subjects and populations

The data were analysed in several steps. First, the data were cross-tabulated to obtain descriptive statistics of the study participants. The data were analysed separately for men and women and by country and the results were expressed

initially as percentages, means, and 95% confidence intervals (95% CI). Continuous variables were summarized as a mean ±SD and categorical variables were summarized by frequency and percentages. The Chi-square statistics ($\chi 2$) and independent sample t-test statistics used for categorical and continuous variables respectively to analyse the significance of differences. One-way analysis of variance (ANOVA) was performed to assess differences in mean CASP-19 scores according to demographic and socioeconomic characteristics of the participants, with a linear trend fitted across hierarchical variables.

In the present study, individuals with missing data in categorical variables were coded as a special “missing” category for the purpose of descriptive analyses. In the Czech Republic and Poland, the study questionnaire was completed at home, prior to the medical examination in a clinic, while in Russia; both parts of the study were performed in a clinic. This explains the smaller proportion of missing data for Russia.

4.3.2 Psychometric evaluation of CASP scales

Second, the internal consistency reliability and validity of the quality of life instrument CASP-19, and three shorter versions of CASP-12 were assessed using Cronbach's alpha, Pearson’s correlation, construct validity and Confirmatory factor analysis (CFA).

Frequency distributions were examined to evaluate the normality of scale items. Missing data, and floor and ceiling effects (percentages of participants indicating minimum and maximum scores) of the CASP-19 were investigated in order to verify the validity and reliability of scale content. Such effects were considered to

be present if more than 15% of the sample reported the lowest or highest score (McHorney and Tarlov, 1995, Terwee et al., 2007). If floor or ceiling effects are present, it is likely that extreme items are missing in the lower or upper end of the scale. In such cases, as a result, participants with the lowest or highest possible scores cannot be distinguished from each other, and reliability of the questionnaire is reduced. Missing item responses up to 10% has been considered as acceptable (af Sandeberg et al., 2010). Internal consistency reliability of CASP-19 was determined using Cronbach's alpha [α]. It evaluates the extent to which items within a scale are inter-correlated with one another and measure the same concept. Cronbach's alpha typically ranges from 0 to 1. Internal consistency reliability is suggested to be acceptable when Cronbach's alpha ≥0.70 (DeVellis, 1991). Item-total correlations were calculated to examine the dimensionality of the scale items. Items within each dimension should represent the same latent variable and correlate more strongly with own domain than others. This is considered satisfactory if item-total correlations are ≥0.40 (Ware and Gandek, 1998b). Construct validity was further examined by analysing the correlation between CASP-19 dimensions with other previously validated measures (Cohen, 2005). Spearman's correlation coefficients were used and were interpreted as follows: : >0.90 excellent relationship, 0.71 to 0.90= Good, 0.51 to 0.70= Fair, 0.31 to 0.50=weak, ≤0.30 none.

Previous quality of life studies have sought to find evidence of construct validity by correlating with other established measures such as the SF-36, self-rated health status, and satisfaction with Life Scales (SWLS) (Bowling, 2005, Sim et al., 2011). Two measures that have been incorporated in the HAPIEE questionnaire were used for this purpose: Physical functioning and self-rated health status.

Physical functioning was measured by the 10 questions on activities of daily living from the SF-36 questionnaire (Ware and Sherbourne, 1992, Mchorney et al., 1993). Respondents were asked to rate their health over the last 12 months. (1= Good/Very good; 2=Average; 3=Poor/Very poor. Higher self-rated health scores indicate poorer heath, and a negative correlation with the CASP-19 would be hypothesized. Conversely, physical functioning was rated on a 0 to 100 scale, with a higher score indicating better physical functioning. CASP-19 should correlate positively with physical functioning. Correlation coefficients between 0.1 and 0.3 are considered low, between 0.3 and 0.5 moderate and over 0.5 high.

Confirmatory factor analysis (CFA)

For Confirmatory factor analysis (CFA) of CASP-19, CASP12v.1 and CASP12v.2, three competing models were tested: 1) Single factor model 2) First-order model 3) Second-order model. A schematic representation of the models can found in Figures 5 to 7.

A single factor model where all 19 or 12 items load directly onto unobserved variable called QOL was tested (Figure 5), followed by a first-order model in which the four domains were included (Figure 6). In the second-order measurement model, the CASP domains are allowed to be dependent upon a single underlying factor, QOL. The second-order model is applicable when 1) the lower order factors are highly correlated with each other, and 2) there is a higher order factor which is hypothesized to account for the relations among the lower order factors. A second-order factor solution with 4 domains was proposed for the 19 item scale (figure 7), and a similar factor structure based on 3 domains was

proposed for CASP12v1 and CASP12v2 (figure 8). In addition, the single and two-factor structure of CASP12v3 as proposed by Sexton et al 2013 were also investigated (figure 12 to 14 see page 121). The two-factor model is composed of control/autonomy and self-realisation/pleasure factors and this includes residual covariances for negative items, in order to take account of method effect that arise from the direction of wording in the scale items (Marsh, 1996). CFA was computed using the Weighted Least Square estimator with a mean- and variance-adjusted Chi-square (WLSMV) method to handle ordered categorical items as dependent variables in Mplus,

Figure 5 Single factor model for CASP-19

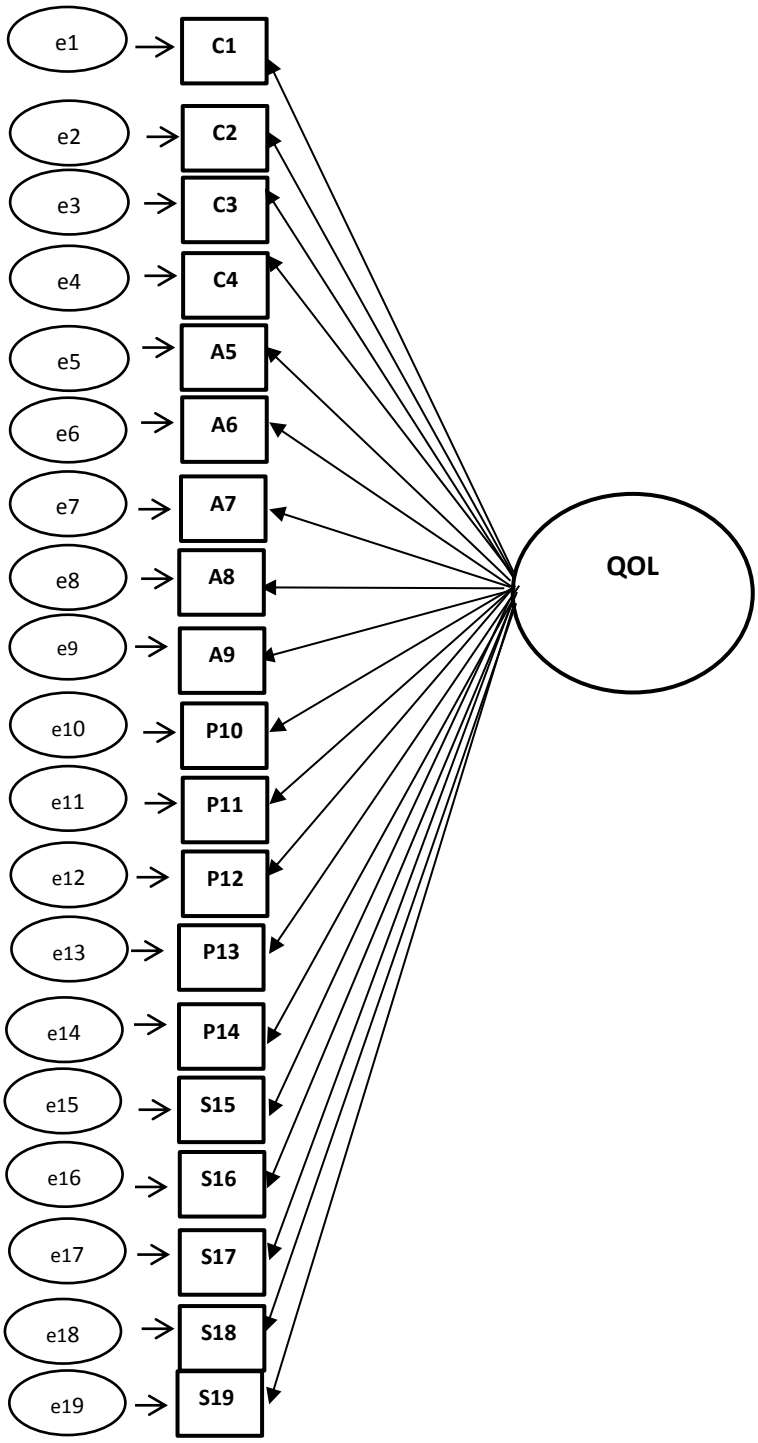


Figure 6 First-order model for CASP-19

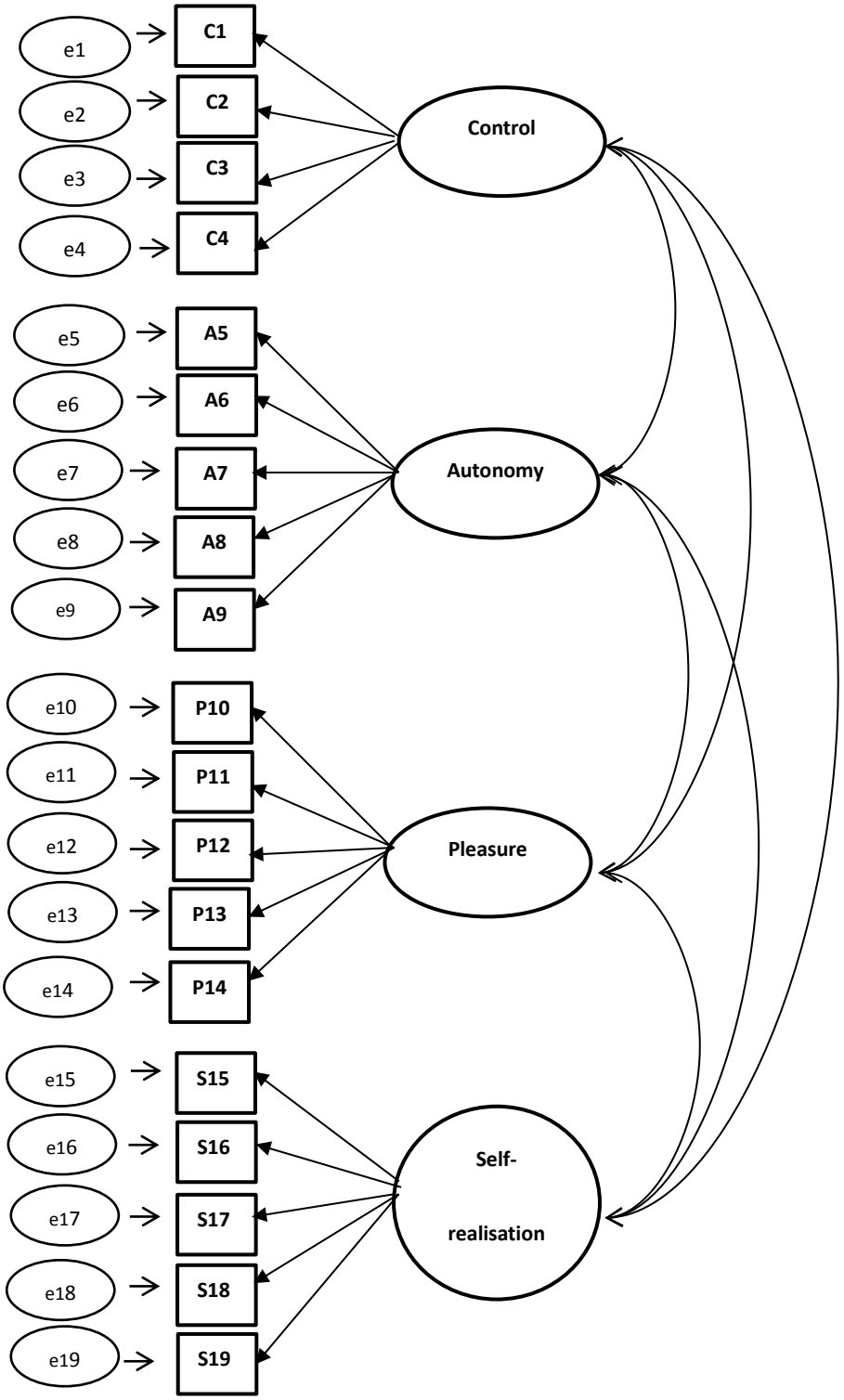


Figure 7 Second-order model for CASP-19

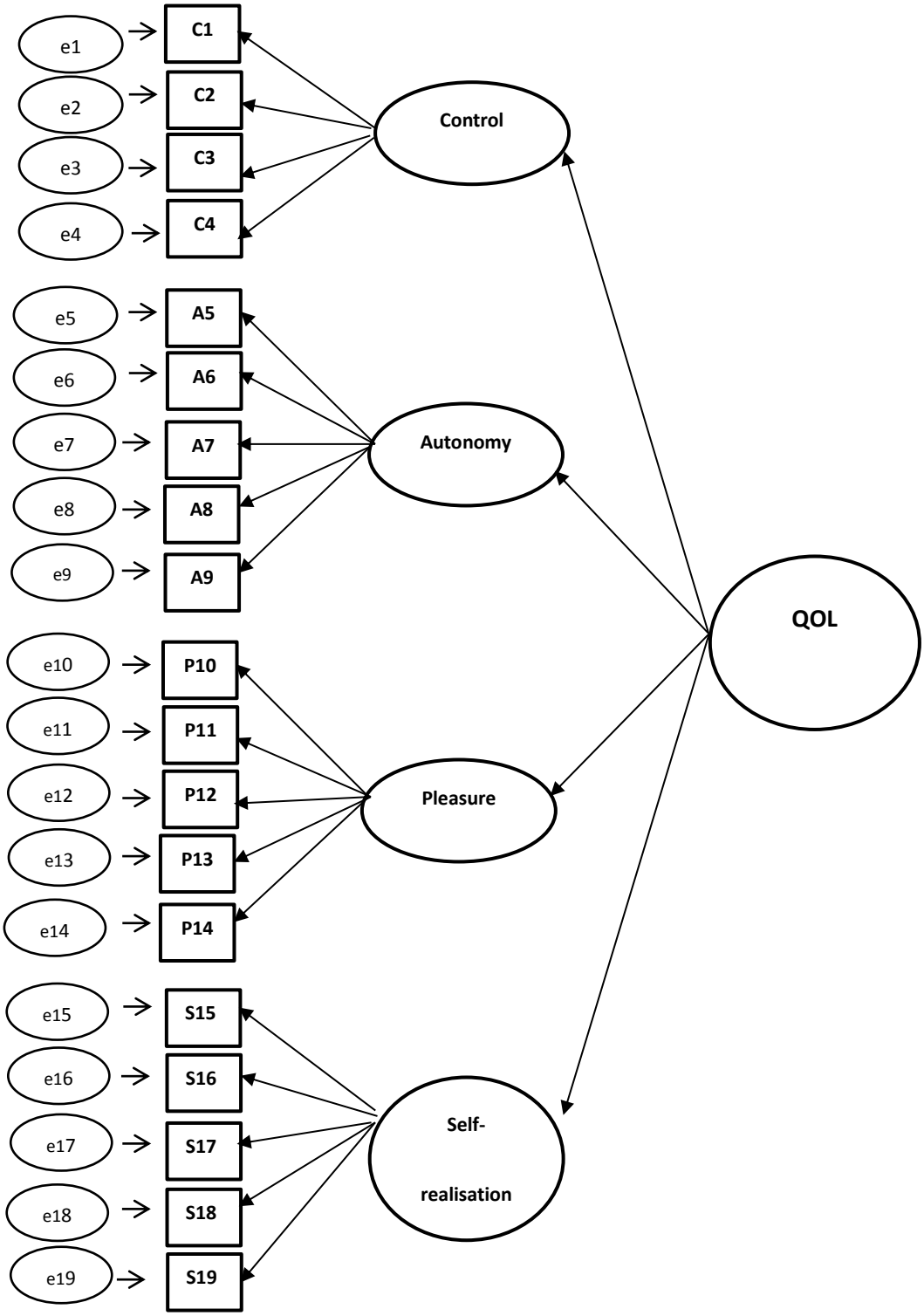
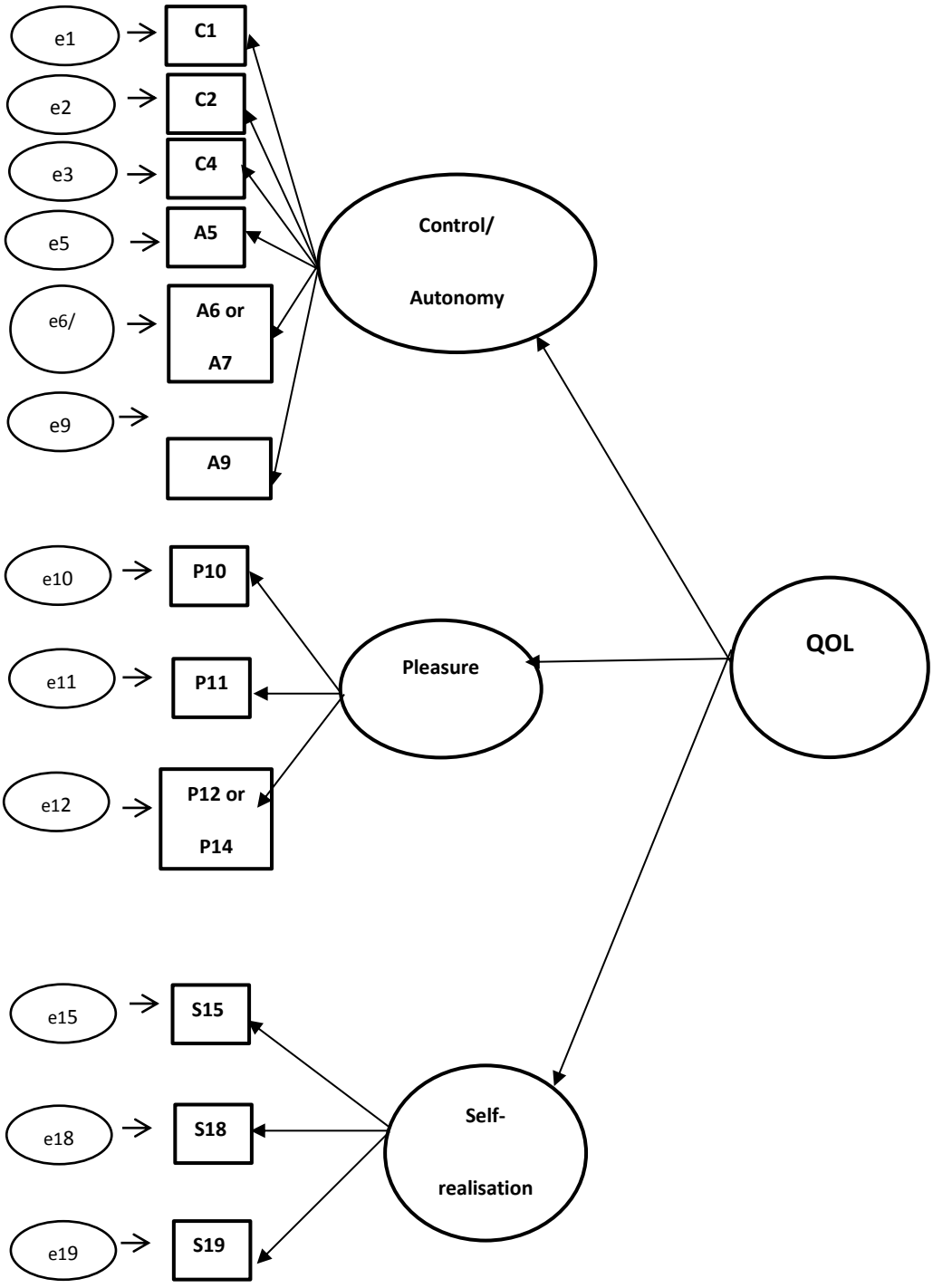


Figure 8 Second-order model for 12-item CASP



Assessing the degree of model fit

To assess the overall fit of the proposed models, four goodness-of-fit indices were calculated. These indices include: Comparative fit index (CFI) (Bentler, 1990); Tucker lewis index (TLI) (Tucker and Lewis, 1973); Root mean square error of approximation (RMSEA) (Steiger, 1989) and Weighted root mean square residual (WRMR)(Yu, 2002).

According to Hu and Bentler (1999), a CFI value of greater than 0.90 can be expected for a psychometrically acceptable fit to the data. RMSEA is another quantitative index which describes how well the model fits the observed data. As a rule of thumb, value of RMSEA less than 0.05 indicates good fit, values between 0.05 to 0.08 suggest acceptable model fit, and values greater than 0.10 suggest poor model fit. For the CFI and TLI, values above 0.90 can be expected for a reasonably good fitting model. For the WRMR values less than 1.0 have been suggested as indicative of adequate model fit (Hancock and Mueller, 2006, Muthen and Muthen, 2010).

4.3.3 Key predictors of CASP in HAPIEE

Third, the role of demographic, socioeconomic, lifestyle risk factors, and health variables in predicting CASP12v3 scores was investigated. Based on the literature, five broad life domains were identified to be associated with CASP among older adults: sociodemographic factors, physical and mental health, behavourial risk factors and social networks. Variables in these domains included age, sex, and age-squared term, education, household amenities scores, material deprivation, employment status, years in retirement, BMI, levels of

physical activity, presence of long-standing illness, physical functioning score, depressive symptoms, and self-rated health status. The associations between CASP scores and explanatory variables were estimated by stepwise multiple linear regression analyses.

First, univariable regression analyses were conducted and only variables that had p-values less than 0.05 were included in the subsequent multivariable linear regression models (results not presented). All the variables used for the descriptive analysis, were included in the multivariable models, except for smoking status as it was not significantly associated with CASP12v3 in the univariable analysis. Stepwise multiple linear regression analyses were performed, with CASP12v3 as the dependent variable. The predictor variables were sequentially entered in four blocks (models), in order to examine the relative contributions of each group of independent variables in explaining the variance in CASP12v3 scores.

Age was initially entered in the first model (Model 1); in model 2, a quadratic relation between age and CASP12v.3 was also tested by including the aged squared term in the model. The third model (model 3) was additionally controlled for marital status and socioeconomic variables (Household amenities, material deprivation, employment status and years in retirement, education). Model 4 adjusted for lifestyle variables (BMI, physical activity) and health variables (self-rated health status, presence of long-term health problems, physical functioning, depressive symptoms). The final model (Model 5) adjusted for variables related to relationship with relatives and friends plus all variables from the previous models. In addition, the models were extended by estimating two-way interactions to determine whether the association between independent variables

and CASP12v3 score differed significantly by gender.

In multivariable linear regression models, the standardized coefficients (βs) were used to compare the strength of the various independent variables. Standardized regression coefficients of 0.1 are considered small, of 0.3 are considered medium, and of 0.5 are considered large for continuous predictors. For binary-coded predictor variables, regression coefficient of 0.2 are considered small, of 0.5 are considered medium, and of 0.8 are considered large (Cohen 1962). The extent to which each step improved the model was evaluated by the change in R-squared value. R-squared reflects the goodness of fit of the regression model and the proportion of variance in the dependent variable that is explained by the independent variables; hence the change in R-squared evaluates the incremental variance explained by each step of the model. All P-values <0.05 were considered to be statistically significant and all tests were two-tailed. The effect sizes of explained variance of 0.02 are considered small, of 0.13 are considered medium, and of 0.26 were considered large.

4.3.4 Association between baseline CASP scores and all-cause mortality

For the analysis of the association between CASP12v3 and all-cause mortality, the data were analysed in four steps. First, difference in characteristics and mean CASP scores between subjects who were alive and those who were deceased at the end of the follow-up were compared; chi-squared tests was used for categorical variables and independent t-tests for continuous variables.

Second, country-specific and gender-specific age-standardized mortality rates

were calculated for each CASP12v3 tertile group. Country-specific tertiles were constructed to provide a relative quality of life measure; therefore, the cut-points for each country are different. Tertiles of CASP12v3 were categorized as high (reference category), intermediate and low. Age-standardized mortality rates were obtained by the direct method, using the European standard population as the reference population (Ahmad et al., 2001). The trend in age-standardized mortality rates across the QOL tertiles was analysed by using the chi-square test for linear trend.

Third, the differences in survival as a function of quality of life were examined graphically by plotting Kaplan-Meier survival curves for each tertile of CASP12v3 scores and the differences in survival between groups were compared using the log rank test, to ascertain the relationship between CASP12v3 scores and outcome. Also, estimates of 5-year cumulative survival rates of the participants in each CASP category were calculated by the life table method (Szklo and Nieto, 2014).

Fourth, to account for variable follow-up times, Cox proportional hazards models were fitted for all-cause mortality data, in order to calculate hazard ratios and corresponding 95% confidence intervals (Cox, 1992). All analyses were performed separately by country cohorts after it was found to modify the relationship between CASP12v3 and mortality (p for interaction<0.001). In each Cox regression model, age at baseline was entered as a continuous variable. Time-on-study (i.e. follow-up time in years since baseline) was used as the time scale. Subjects alive at the end of follow-up were treated as censored. The proportional hazard assumption was tested in all Cox models using the global test based on Schoenfeld residuals (Schoenfeld, 1982, Glidden et al., 2011). The

first estimated models were adjusted for age, age-squared term and gender, with CASP12v3 scores divided into tertiles in order to test for a dose-response relationship. Subsequently, multivariable Cox models were fitted to account for confounding variables. Potential confounders of the CASP and all-cause mortality relationship were selected based on prior knowledge and by assessing whether each variable correlates with both all-cause mortality and CASP12v3 in the study sample. The fully adjusted multivariable models controlled for age, sex, marital status, SEP, baseline depressive symptoms, physical activity, obesity, physical health variables and frequency of contact with friends and relatives. To further understand the role that age and sex might play in these associations, the models were also estimated including an interaction term between age group and CASP12v3 score, sex and CASP12v3 score to test whether age and sex modified the association between CASP score and mortality.

As part of auxiliary analyses, domain-specific analyses were also conducted where the four domain scores of CASP-19 were mutually adjusted for each other and other relevant confounder (See appendices 1 to 3 page 212).

4.3.5 Mediation analyses: estimation of direct and indirect effects of CASP12v3 score on mortality through mediators.

Prior to mediation analyses, correlation analyses were carried out, separately for each cohort, in order to provide an overview of the relations between the study variables. The following variables were used: age, gender, marital status, SEP (material deprivation, education, household assets), social network variables (Frequency of contact with friends and relatives), mental health (depressive symptom), body mass index, physical activity, physical health variables (Long-term health problems, physical functioning, self-rated health), all-cause mortality

and CASP12v3. To assess the assumption of no multi-collinearity, Spearman rank correlation was inspected. Cohen provided rules of thumb for interpreting these effect sizes, suggesting that an *r* of |.1| represents a 'small' effect size, |.3| represents a 'medium' effect size and |.5| represents a 'large' effect size (Cohen, 1988).

Principal component analysis (PCA)

Inspection of the correlation matrix determined that multi-collinearity exists among the three SEP variables and among the physical health variables (r ≥0.3). In each case, principal component analysis (PCA) was performed to reduce the dimensionality of data and to investigate the nature of the relationships among the variables with the main purpose of isolating the general features that best describe the variations in the data. Using this technique, 3 inter-correlated socioeconomic and physical health factors were each reduced to a single principal component which explained most of the variation in socioeconomic and physical health characteristics in each of the three cohorts. Kaiser criterion (eigenvalue one test) was used to guide the decision on the number of principal components to retain; eigenvalues >1, examination of the scree plots and the cumulative proportion of variance explained by each component or factor were taken as criteria for extraction (Kaiser, 1960). To maximize the variance of factor loadings and therefore aid the separation of variables into homogeneous groups, varimax rotation was used (Fayers and Machin, 2007).

Mediation analyses

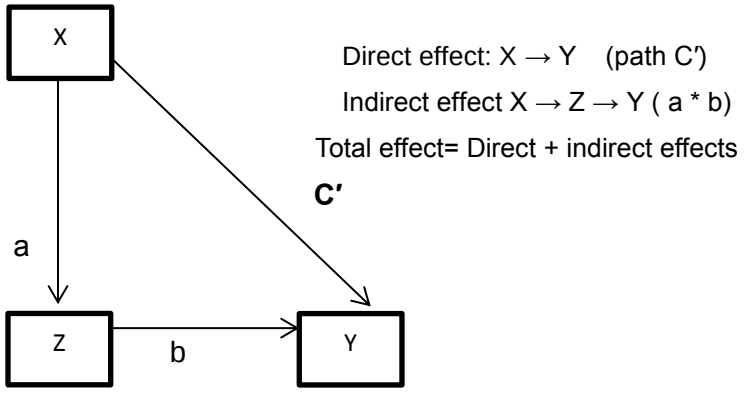
Next, mediation analyses was conducted in Mplus (Muthén and Muthén, 2010), by testing proportional hazard models in a structural equation modeling (SEM)

framework. Of specific interest was whether social relationship variables, physical health, or health behaviour variables each mediate the effects of CASP12v3 on all-cause mortality, after controlling for the effects of age, sex, sociodemographic variables and depressive symptoms.

Mediation analysis investigates whether the mediating variable accounts for a significant amount of the shared variance between the independent and the dependent variable (Baron and Kenny, 1986, MacKinnon et al., 2007). According to Baron and Kenny (1986), the following conditions must be met to establish mediation:1) significant relationships exist between the independent variable, and the mediating variables 2) the potential mediators are significantly related to the dependent variable and 3), the addition of the mediators to the regression models used in the first step greatly reduces or removes the significant relationship between independent and the dependent variables.

Unlike the traditional causal steps approach (Baron and Kenny, 1986) for testing mediation effects, which does not provide a direct estimate of the size of the indirect effect, or standard errors, the proportional hazards modeling through an SEM framework allows decomposition of the total effects of CASP12v3 score on mortality into direct and indirect for censored outcomes such as survival time (Turiano et al., 2012, Ploubidis and Grundy, 2009, Asparouhov et al., 2006). Also, SEM enables simultaneous testing of multiple mediating pathways in a single model, which is essential because there are likely to be various different pathways that explain the link between CASP and mortality.

Figure 9 Direct and indirect effects in mediation analysis



The structural part of the SEM involves a path analysis to estimate regression coefficients representing the direct relationships between variables of interests (path a Figure 9). In addition, SEM allows analysis of the indirect effects (amount of mediation) of independent variables on dependent variables through the effects of mediating variables (a * b) (Kline and Santor, 1999). Mediating effects show the impact of a predictor variable on the specific variable of interest which is partially or fully explained by another variable.

In the present study, proportional hazard models in a structural equation modeling (SEM) framework were estimated by means of maximum-likelihood estimation (MLR), and Monte Carlo integration. MLR provides parameter estimates that are robust to non-normal outcomes. Owing to the use of time-to-event outcomes, no commonly used test statistics and goodness-of-fit indexes were available to examine the overall fit of the model to the data because means, variances and covariances are not sufficient for model estimation in Mplus.

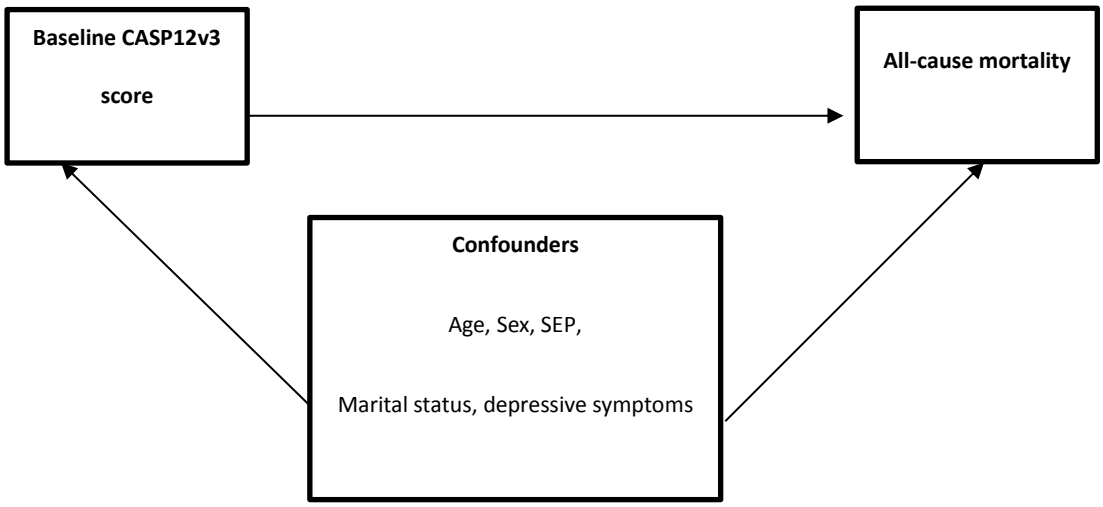
Mplus uses the Sobel product of the coefficient method to calculate indirect effects in a mediation model (MacKinnon et al., 2002, Sobel, 1982). Specifically, for a given mediator, the indirect effect is quantified by multiplying the regression coefficient of the independent variable on the mediator (path a) and the regression coefficient (path b) of the mediator on the dependent variable (a × b) (See figure 9). For example, the effect of CASP12v3 score on physical health was multiplied by the effect of physical health on mortality. Accordingly, the size of the total indirect effect were obtained by the adding all specific indirect effects. The total effect of the independent variable on the dependent variable comprises a direct effect (path C′) of the independent variable on the dependent variable and a total indirect (mediated) effects (a * b) through all the mediators. If the coefficient for the direct effect remains statistically significant and there is significant indirect effect through the mediator, then there is evidence for partial mediation. The estimated coefficients were then exponentiated to obtain the hazard ratios (HR) for the indirect effects. The total HR effects were calculated by taking the exponentiation of the summed direct and indirect coefficients.

In addition, the proportion mediated by each risk factor was also calculated, where possible, to provide information about the magnitude of the mediated effects. The proportion mediated is a way of assessing the relative contribution of each mediator in a multiple mediator model by indicating what proportion of the total effect is attributable to individual meditational pathways. This was calculated as the risk factor-specific indirect effect divided by the total effect of CASP12v3 on mortality; these proportions were multiplied by 100 to approximate the percentage of the total CASP-mortality association mediated by each risk factor.

Figure 10 illustrates a direct association between baseline CASP12v3 score and all-cause mortality.

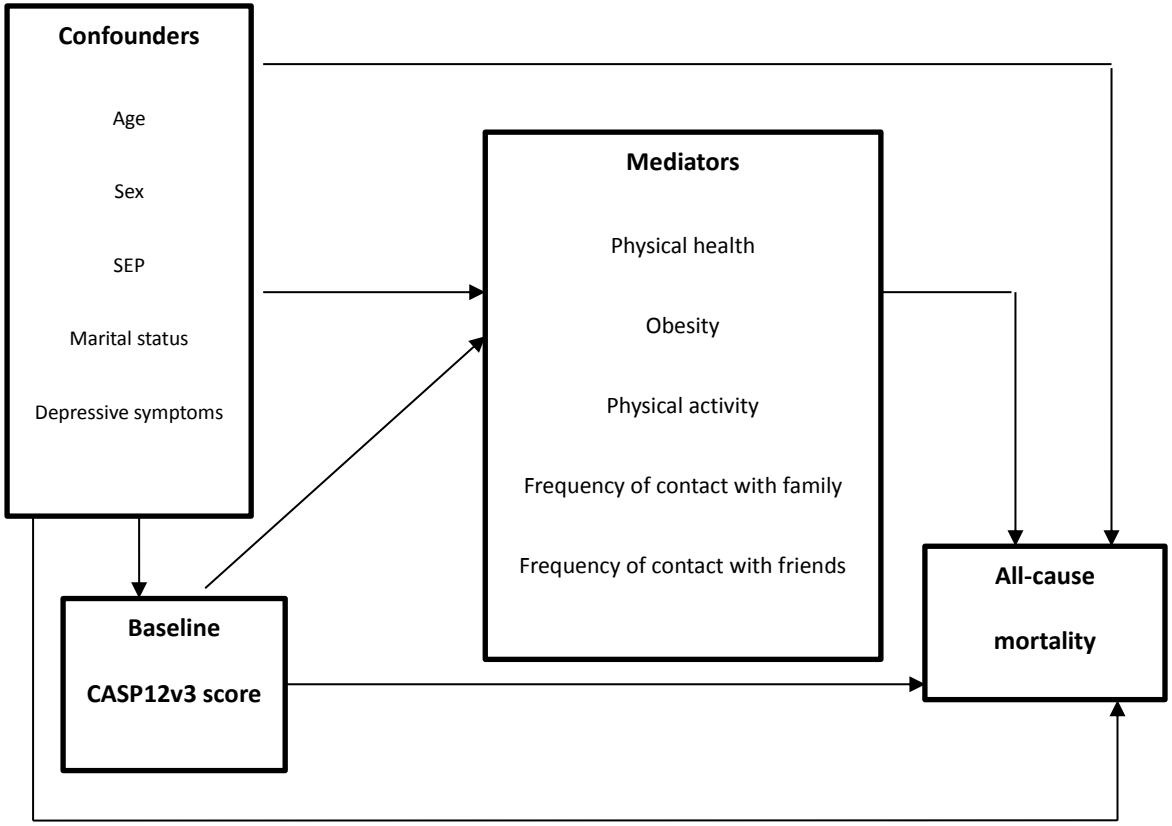
The mediation analyses were performed in three steps: In the first step, a model examining only the direct relationship between CASP12v3 score and all-cause mortality was fitted separately for each cohort (Figure 10). Variables which were found to be correlates of CASP and of mortality were included in the model as control variables: age, sex, marital status , socioeconomic position, and depressive symptoms. The outcome was all-cause mortality and the exposure variable was continuous CASP12v3 score of quality of life measured at baseline. Secondly, simple mediation analyses were performed, which examined the relationships among CASP12v3 score, each mediating variable, and all-cause mortality (Figure 11). Five mediating variables were hypothesized to influence the quality of life and mortality relationship: physical heath, obesity, physical activity, frequency of contact with family, and frequency of contact friends. Finally, all the significant mediators identified in step two were tested in a multiple mediation model. Variables which did not indicate significant indirect effects at the P value level of 0.05 at stage two were also included in the final multiple mediation model as confounders to minimize possible confounding by these risk factors.

Figure 10 Path diagram showing the direct effect of baseline CASP12v3 score on all-cause mortality .



Footnote: Path diagram showing the hypothetical cause-and-effect relationship between the main exposure and the outcome variable. Controlling variables were age, sex, marital status, SEP and depressive symptoms.

Figure 11 Simplified hypothetical causal path diagram for relationship between all-cause mortality, mediators and CASP12v3.



4.4 Strategies for handling missing data in the HAPIEE cohort.

When routinely collected data are used, which is often the case in the field of epidemiology, the determinant of interest or the confounders you want to adjust for can have missing values. Ignoring the missingness in the data can lead to biased parameter estimates and can have implications on the reliability, validity and generalizability of research findings (Graham, 2009)

The choice of how to deal with missing data depends on the mechanisms of missingness. In this regard, data can be either missing at random (MAR), missing not at random (MNAR), or missing completely at random (MCAR) (Rubin, 1976, Little and Rubin, 1987). When data are MAR, the missing data are dependent on some other observed variables rather than any unobserved one. When data are MAR or MCAR, they are often referred to as ignorable (provided the cause of MAR is taken into account). MNAR on the other hand, is non-ignorable missingness meaning that, given the observed data the missingness mechanism depends on unobserved data.

In this thesis, missing data was handled in two ways. The first is through listwise deletion or the complete cases analysis, where participants with missing baseline values across the CASP-19 items were excluded from the main analyses. This technique is suitable for data that are missing completely at random (MCAR) and provides good parameter estimates even when the missing data are non-ignorable (Allison, 2002). Complete case approach is known to lead to reduced statistical power (Sterne et al., 2009), but for many analyses this was not a substantial problem in HAPIEE study because the sample sizes of the cohorts are large.

Second, Full Information Maximum Likelihood (FIML) estimation as implemented in Mplus was used to handle missing data, in order to check the robustness of main complete case analyses (Enders and Bandalos, 2001, Zaninotto et al., 2010, Larsen, 2011). In this project, FIML was used in estimation of mediation models presented in Chapter 5.5 and for the evaluation of the psychometric properties of CASP in HAPIEE (Chapter 5.2). In FIML method, missing data were not imputed; rather, it directly estimates model parameters using all available data, including mean and variance for the missing portions of a variable, given the observed portions of other variables. FIML produces consistent and efficient estimates when data are missing at random (MAR) (Little and Rubin, 1989, Little and Rubin, 2014); and the procedure has also been shown to produce less biased parameter estimates than other methods even when the data deviate from the MAR assumption (Enders, 2001).

4.5 Power of the study

This thesis was based on existing HAPIEE data, and, therefore, the size of the samples could not be influenced. As the main association of interest is between the CASP (exposure), and all-cause mortality (outcome), only the cases with available data on both exposure and outcome are included in the survival analyses. Therefore, the calculation of the study power is also based on the complete case approach.

During the period for which the complete data on all-cause mortality were available for HAPIEE participants (until the end of 2011 for the Czech Republic, and until the end of 2010 for Russia, mortality was followed until the end of 2009 for Poland.), the observed number of deaths in each country was 307, 597, and

583, respectively.

Post-hoc power calculations were performed using the stpower Cox utility of the STATA statistical package. Assuming that the confidence level is 95% or 99%, and the lowest hazard ratio (HR) for the comparison of mortality rates is 1.25, the study power was calculated for each HAPPIE sample. The ideal power for any study is considered to be at least 80% (Suresh and Chandrashekara, 2012). As shown in Table 2, for the 95% CI and the minimal hazard ratio of 1.25, statistical power was between 62.2% and 85.6%. The Czech sample with only 307 events had the lowest power of 62.2 % power to detect a hazard ratio of 1.25, although it had sufficient power to detect hazard ratio of 1.50 (>97%).

Table 2 Study power calculation for HAPIEE samples

Hazard ratio	**Study power**	
Czech Republic	**95% CI**	**99% CI**
1.25	62.2%	35.5%
1.50	97.2%	89.0%
2.00	>99.9%	99.9%
2.25	>99.9%	99.9%
Russia		
1.25	85.6%	65.6%
1.50	>99.9%	99.6%
2.00	>99.9%	>99.9%
2.25	>99.9%	>99.9%
Poland		
1.25	85.2%	64.2%
1.50	>99.9%	99.5%
2.00	>99.9%	>99.9%
2.25	>99.9%	>99.9%

4.6 Software

Data were analysed using statistical packages STATA for Windows, versions 12 and 13 (Stata Corporation, College Station, USA), and Mplus for Windows, versions 6.11.

4.7 Ethical Approval

The study received ethical approval from the UCL/UCLH joint research ethics committee and from ethical committees in each participating country. All participants gave written informed consent. All data used in the analysis were anonymised.

Chapter 5

Results

Results chapter is presented in five sections. First, descriptive characteristics of the study populations are displayed. Second the results of psychometric properties analysis including confirmatory factor analysis of CASP are presented. Key results illustrated in Chapter 5.2 have been published in *Ageing & Mental health*. The complete reference is: Kim GR, Netuveli G, Blane D, Peasey A, Malyutina S, Simonovav G, et al. (2014). Psychometric properties and confirmatory factor analysis of the CASP-19, a measure of quality of life in early old age: the HAPIEE study Jul 26; 1-15. Third, results on analysis of predictors of CASP in HAPIEE are presented. Fourth, findings of the Cox regression analysis which examined the relationship between CASP and all-cause mortality are shown. Finally, mediation analyses results are presented which show the direct and indirect effects of CASP on mortality through the proposed mediating variables.

5.1 Descriptive characteristics of study participants

Table 3 shows the baseline socio-demographic, health, and lifestyle characteristics of the study participants. In each samples, the proportion of women was higher than the proportion of men and ranged from 54.1% (Poland) to 64.1% (Russia). Mean age of the subjects in the samples ranged between 62.6 (Poland) and 65.2 years (Czech Republic) among men. In women, mean age of the sample varied between 61.8 (Poland) and 63.5 years (Czech Republic). Males were older than female participants.

There were differences in socio-demographic characteristics between the samples. For example, there was higher prevalence of individuals who achieved university education in Russia, and in all countries education level was higher among men than women. Compared to Czech and Polish women, there was a large proportion of widows and lower proportion of married or cohabiting women in Russia. Four times as many Russian women (29.4%) were widowed, compared to men (7.3%). In regards to economic status, the Russian sample consisted only of non-working pensioners, while proportion of Czech and Polish individuals still working were similar. In both men and women, Russian reported higher levels of self-reported material deprivation (9.9% and 11.1% for men and women respectively) compared to Czechs and Poles. Russians reported higher levels of poor/very poor health than Czechs (For women 35.1% vs. 10.8%), while also presenting lower rates of very good/good health (For women 3.0% vs. 33.5% $P<0.001$). The mean body mass index for Russian women was 30.8, which was on average higher than in Czech Republic and Poland. Among Russian men, the mean BMI was 26.5, which was lower than the rest of the sample

Table 3 Characteristics of study participants at baseline by country and gender

	Men			Women		
	Czech Republic (N=1,171)	**Russia (N=1,367)**	**Poland (N=2,438)**	**Czech Republic (N=1,645)**	**Russia (N=2,444)**	**Poland (N=2,869)**
Age (Mean, SD)	65.2 (3.6)	64.0 (4.5)	62.6 (5.1)	63.5 (3.9)	63.1 (4.6)	61.8 (5.2)
Age group (years, %)						
50-54	1.6	5.8	9.3	0.4	4.3	11.4
55-59	5.2	11.5	20.9	19.6	23.4	25.3
60-64	37.4	31.8	30.9	42.3	31.1	30.5
65-69	50.4	47.7	36.4	35.1	39.2	31.1
70+	5.4	3.2	2.5	2.6	2.0	1.7
Education level						
Primary	6.2	21.1	14.3	22.1	16	18.9
Vocational	43.6	20.9	31.6	32.5	27	15.9
Secondary	33.4	33.4	33.9	37.6	37.7	45.5
University	16.1	24.6	20.1	7.4	19.3	19.6
Missing value	0.7	0	0.1	0.4	0	0.1
Household amenities score (0-24)						
Bottom tertile (Low amenities level)	33.0	31.7	29.5	39.6	36.9	38.1
Middle tertile	34.2	30.9	41.9	34.3	34.6	41.8
Top tertile (High amenities level)	32.8	37.4	28.6	26.1	28.5	20.1
Missing value	0.0	0.0	0.0	0.0	0.0	0.0
Material deprivation score						
Low (0)	76.8	31.8	66.4	68.1	22.3	55.8
Medium (1-6)	22.6	58.3	31.8	30.9	66.6	41.1
High (7-9)	0.6	9.9	1.8	1.0	11.1	3.1
Missing value	0.0	0.0	0.0	0.0	0.0	0.0

Table 3. (Continued)	Men			Women		
	Czech Republic (N=1,171)	**Russia (N=1,367)**	**Poland (N=2,438)**	**Czech Republic (N=1,645)**	**Russia (N=2,444)**	**Poland (N=2,869)**
Occupational status						
Working pensioner	13.6		13.1	8.1		8.9
Non-working pensioner	84.5		86.8	91		91.1
Missing value	0.9		0.1	0.9		0.0
Years in retirement - Mean (SD)	6.3 (0.1)	8.0 (0.1)	8.5 (0.1)	7.8 (0.1)	9.3(0.1)	9.7 (0.1)
Marital status						
Married or cohabiting	86.1	85.2	85.1	66.6	54.4	61.7
Single	1.4	1.9	3.2	1.8	3.6	5.8
Divorced	6.4	5.6	5.7	11.2	12.6	7.9
Widowed	5.9	7.3	5.7	20.3	29.4	24.5
Missing value	0.2	0.0	0.3	0.1	0.0	0.1
Health status						
Very good and good	33.2	8.3	25.6	33.5	3.0	20.2
Average	56.3	60.2	54.8	55.3	61.9	58.9
Poor and very poor	10.1	31.5	19.5	10.8	35.1	20.7
Missing	0.4	0.0	0.1	0.4	0.0	0.2
Long-term health problems						
No	34.0	52.0	34.7	29.9	47.7	28.7
Yes	64.7	48.0	64.8	69.2	52.3	70.7
Physical functioning score (1-100), mean (S D)	82.9 (0.5)	77.1 (0.7)	77.9 (0.50	78.6 (0.5)	71.1 (0.5)	72.2 (0.4)
Lowest (worst)	31.6	31.6	30.0	43.1	42.2	41.2
Middle	30.2	33.6	37.5	29.7	39.7	38.3
Highest (Best)	37.5	34.8	31.8	26.3	18.1	19.7
Missing	0.7	0.0	0.7	0.9	0.0	0.8
Depressive symptoms (CES-D 20)						
No	84.6	55.1	76.5	73.3	45.1	64.7
Yes	10.3	14.6	22.0	21.5	28.9	33.8

Table 3. (Continued)	Men			Women		
	Czech Republic (N=1,171)	**Russia (N=1,367)**	**Poland (N=2,438)**	**Czech Republic (N=1,645)**	**Russia (N=2,444)**	**Poland (N=2,869)**
Missing value	5.1	30.3	1.5	5.2	26.0	1.5
Smoking						
Never	31.4	25.4	27.3	60.5	91.8	56.9
Past	44.2	28.9	41.1	21.8	2.6	20.6
Currently	23.5	45.7	31.2	17.4	5.6	22.3
Missing value	0.9	0.0	0.4	0.3	0.0	0.2
Physical activity Hours per week – mean (SD)	5.2 (6.2)	2.6 (0.2)	6.4 (0.1)	4.9 (5.8)	2.0 (0.1)	5.6 (0.1)
Missing value	4.3	0.0	5.2	3.8	0.0	5.1
BMI (mean, SD)	28.7 (4.1)	26.5 (4.5)	28.3 (4.1)	29.2 (4.9)	30.8 (5.7)	29.2 (5.1)
Underweight (BMI < 20 kg/m2);	0.6	5.9	1.6	0.9	1.7	1.4
Normal weight (BMI 20.0-24.9 kg/m2)	13.2	33.7	15.8	15.7	12.7	17.2
Overweight (BMI 25-29.9 kg/m2)	42.4	39.4	43.4	34.2	33.2	32.1
Obese (BMI>30kg/m2)	27.7	21.0	26.7	34.3	52.4	35.4
Missing value	16.3	0.0	12.5	14.9	0.0	13.9
Frequency of contact with relatives						
No relatives	1.0	3.6	4.3	1.0	3.2	4.8
Less than once a month	12.5	29.1	30.8	6.2	21.8	24.1
Once a month or more	29.0	23.3	36.6	22.8	20.0	34.1
Once a week or more	57.2	44.0	28.2	68.8	55.0	36.6
Missing value	0.3	0.0	0.1	1.2	0.0	0.4
Frequency of contact with friends						
No relatives	3.2	18.7	9.5	2.6	11.8	8.1
Less than once a month	24.4	36.0	33.9	18.0	40.1	27.3
Once a month or more	44.7	22.8	37.3	41.2	23.4	38.3
Once a week or more	27.2	22.5	18.7	37.5	24.7	25.5
Missing value	0.5	0.0	0.6	0.7	0.0	0.8

Table 4 describes differences in mean CASP-19 scores across demographic and socio-economic variables between the three cohorts. For the HAPIEE samples, the percentage of missing data was generally low. An analysis of variance (ANOVA) of CASP-19 scores showed that there are statistically significant differences in mean CASP-19 values across the three cohorts on all demographic and socio-economic status variables ($p<0.001$). Relative to women, men had significantly higher mean scores on the CASP-19 across all three HAPIEE populations. Polish men and women reported the highest CASP-19 scores (Mean scores 38.5, 95% CI= 38.1 to 38.9; 37.2, 95% CI= 36.9 to 37.5 respectively), while lowest mean CASP-19 scores were reported by Russian men and women (Mean score= 34.4, 95% CI= 34.0 to 34.9; Mean score= 33.1, 95% CI=32.8 to 33.4 respectively). In all samples, individuals with higher levels of education reported higher CASP-19 scores compared with those with less education. CASP-19 scores were significantly lower in non-working pensioners than those in employment. In all countries and gender, mean CASP-19 scores were significantly different between household amenities groups; higher mean CASP-19 scores were reported by those in the highest tertile group of household amenities score compared with their counterparts in the lowest tertile group. Overall, quality of life of married or cohabiting respondents was significantly higher than that of the other participants. In general, women who divorced recorded the lowest quality of life in our study. Also, Polish divorced men reported the lowest mean CASP-19 score. Among men, lowest mean CASP-19 scores was reported by Czech and Russian men who never married, compared to widowed or divorced persons.

In the descriptive analysis, statistically significant differences between the mean

CASP-19 scores were found across the five age groups. For example, in the Czech samples quality of life decreased with increasing age. In Russia and Poland, quality of life increased between 50 to 54 years and 60 to 64 years old. Afterwards, there were declines in quality of life between 65 to 69 years and 70 years.

Table 4 CASP-19 scores according to socio-demographic variables in sample of participants with complete information on CASP-19

	Men			Women		
	Czech Republic (N=1,171)	**Russia (N=1,367)**	**Poland (N=2,438)**	**Czech Republic (N=1,645)**	**Russia (N=2,444)**	**Poland (N=2,869)**
All	38.0 (37.5 to 38.4)	34.4 (34.0 to 34.9)	38.5 (38.1 to 38.9)	37.1 (36.7 to 37.5)	33.1 (32.8 to 33.4)	37.2 (36.9 to 37.5)
Age group (years)						
50-54	41.2 (37.5 to 44.8)	35.1 (32.9 to 37.4)	37.1 (35.8 to 38.3)	40.3 (34.3 to 46.3)	32.9 (31.1 to 34.7)	36.0 (34.9 to 37.0)
55-59	38.0 (35.8 to 40.1)	34.8 (33.3 to 36.4)	37.8 (37.0 to 38.7)	37.6 (36.8 to 38.4)	34.7 (33.9 to 35.4)	37.7 (37.0 to 38.4)
60-64	38.5 (37.8 to 39.2)	35.5 (34.6 to 36.4)	39.0 (38.4 to 39.6)	37.3 (36.7 to 37.9)	33.7 (33.1 to 34.2)	37.6 (37.0 to 38.2)
65-69	37.5 (36.8 to 38.1)	33.8 (33.1 to 34.4)	38.8 (38.2 to 39.4)	36.7 (36.1 to 37.3)	31.9 (31.4 to 32.4)	36.8 (36.2 to 37.3)
70+	37.8 (35.8 to 39.7)	32.0 (29.3 to 34.7)	39.3 (37.2 to 41.3)	35.1 (32.8 to 37.4)	31.9 (31.4 to 32.4)	39.1 (36.9 to 41.3)
Education level						
Primary	36.6 (34.8 to 38.4)	31.9 (30.9 to 32.9)	35.9 (34.9 to 36.9)	35.9 (35.1 to 36.7)	30.4 (29.6 to 31.2)	34.6 (33.8 to 35.3)
Vocational	37,3 (36.6 to 37.9)	34.6 (33.6 to 35.6)	38.3 (37.7 to 38.9)	36.6 (36.0 to 37.3)	33.2 (32.6 to 33.9)	37.0 (36.2 to 37.8)
Secondary	38.7 (37.9 to 39.5)	34.3 (33.4 to 35.1)	38.6 (38.0 to 39.2)	37.9 (37.3 to 38.5)	33.0 (32.5 to 33.6)	37.5 (37.0 to 38.0)
University	39.1 (38.0 to 40.1)	36.8 (35.7 to 37.8)	40.6 (39.8 to 41.4)	39.0 (37.6 to 40.5)	35.2 (34.5 to 36.0)	39.2 (38.5 to 39.9)
Household amenities score (0-12)						
Bottom (poor)	37.4 (36.7 to 38.0)	31.5 (30.8 to 32.2)	34.9 (34.3 to 35.4)	37.8 (37.2 to 38.5)	31.0 (30.6 to 31.5)	35.3 (34.9 to 35.8)
Middle tertile	37.6 (36.7 to 38.5)	34.9 (34.2 to 35.7)	39.6 (39.1 to 40.2)	36.5 (35.8 to 37.3)	34.0 (33.4 to 34.5)	38.2 (37.7 to 38.8)
Top (Richest)	39.1 (38.3 to 39.9)	39.5 (38.4 to 40.6)	42.3 (41.7 to 42.8)	37.0 (36.5 to 37.6)	37.4 (36.6 to 38.2)	40.8 (40.0 to 41.5)
Occupational status						
working pensioner	40.4 (39.3 to 41.4)		41.0 (40.2 to 41.9)	39.0 (37.6 to 40.5)		40.9 (40.0 to 41.9)
Non-working pensioner	37.6 (37.1 to 38.1)	34.4 (34.0 to 34.9)	38.1 (37.7 to 38.5)	36.9 (36.5 to 37.3)	33.1 (32.8 to 33.4)	36.9 (36.5 to 37.2)
Marital status						
Married or cohabiting	38.1 (37.6 to 38.6)	34.9 (34.3 to 35.4)	39.0 (38.7 to 39.4)	37.6 (37.2 to 38.1)	33.5 (33.1 to 34.1)	38.1 (37.7 to 38.5)
Single	33.5 (28.7 to 38.3)	30.6 (26.8 to 34.3)	35.1 (32.8 to 37.3)	37.3 (33.8 to 40.8)	32.9 (31.2 to 34.5)	36.9 (35.5 to 38.3)
Divorced	36.6 (34.9 to 38.3)	32.0 (30.0 to 34.0)	34.4 (32.6 to 36.2)	35.6 (34.5 to 36.6)	32.3 (31.3 to 33.3)	34.6 (33.4 to 35.9)
Widowed	38.8 (36.7 to 40.9)	32.6 (30.7 to 34.5)	36.8 (35.3 to 38.3)	36.3 (35.4 to 37.2)	32.5 (31.9 to 33.1)	36.0 (35.3 to 36.6)

Significant differences between men and women by independent t-test.

Significant associations between CASP-19 and socio-demographic variables by One-way analysis of variance (ANOVA).All P-values < 0.001

5.2 Psychometric evaluation of CASP scales

Frequency distributions of CASP-19 scale items

Table 5 shows the frequency distribution and the proportion of missing values of individual CASP-19 scale items in HAPIEE data. There was a skewed score distribution of CASP-19 (skewness -0.96,-0.09, -0.28 for Czech Republic, Russia, Poland respectively). In the Czech sample, the median total CASP-19 score was 36. Median scores for each CASP-19 sub-scale were as follows: Control=6 (IQR 4-8), Autonomy= 9 (IQR 7-11), Self-realisation= 8 (IQR 6-10), and Pleasure= 13 (IQR 11-15). Among Russian participants, median scores for each CASP-19 sub-scale were: Control= 6 (IQR 4-8), Autonomy= 8 (IQR 7-10), Self-realisation 7= (IQR 4-10), and Pleasure= 13 (IQR 10-15. In Poland, median scores were Control=7 (IQR 5-9), Autonomy=8 (IQR 6-10), Self-realisation=10 (IQR 8-12), and Pleasure=14 (IQR 12-15).

Most of the participants completed all 19 items. Missing data was relatively small, with between 0.5 to 6.7 percent not providing a response to an item. Moreover, a marked ceiling effect was found in the pleasure domain, with the highest ceiling effect of 67.3%. (Czech Republic); 70.4% (Russia); 76.2% (Poland).

Table 5 Item response proportions and % missing values for the CASP-19 scale

	Czech Republic						Russia						Poland				
	0 (%)	**1 (%)**	**2 (%)**	**3 (%)**	**Missing (%)**		**0 (%)**	**1 (%)**	**2 (%)**	**3 (%)**	**Missing (%)**		**0 (%)**	**1 (%)**	**2 (%)**	**3 (%)**	**Missing (%)**
c1	16.2	45.4	20.5	12.5	5.4	**c1**	**30.7**	37.8	13.7	17.8	0	**c1**	**20.8**	32.3	21.0	**25.2**	0.7
c2	**23.5**	41.7	17.1	12.2	5.5	**c2**	13.2	47.7	20.1	19.0	0	**c2**	8.9	24.2	20.2	**45.6**	1.1
c3	16.7	24.0	34.7	18.4	6.2	**c3**	16.5	19.4	29.5	**34.6**	0	**c3**	**25.5**	38.7	25.4	9.5	0.9
c4	3.7	20.0	23.4	**46.3**	6.6	**c4**	17.8	44.2	19.0	19.0	0	**c4**	3.6	13.9	15.9	**65.1**	1.5
a5	5.3	11.6	32.4	**45.6**	5.1	**a5**	4.5	14.0	33.1	**48.4**	0	**a5**	14.2	27.7	29.9	**27.3**	0.9
a6	6.1	26.8	29.1	**30.7**	7.3	**a6**	8.9	28.7	21.0	**41.4**	0	**a6**	13.8	26.1	21.1	**37.8**	1.2
a7	1.9	6.4	34.9	**51.5**	5.3	**a7**	1.9	3.8	27.6	**66.7**	0	**a7**	2.3	8.6	34.9	**53.3**	0.9
a8	**22.7**	37.9	22.0	12.9	4.5	**a8**	**42.5**	39.7	8.9	8.9	0	**a8**	**36.6**	33.8	14.1	14.7	0.8
a9	**24.7**	37.5	19.5	13.1	5.2	**a9**	**54.2**	32.4	8.1	5.3	0	**a9**	**47.7**	33.2	10.8	7.6	0.7
p10	0.9	4.6	20.1	**71.1**	3.3	**p10**	6.3	11.2	19.8	**62.7**	0	**p10**	1.2	4.0	18.1	**76.2**	0.5
p11	1.3	5.8	28.4	**60.1**	4.4	**p11**	5.2	16.0	24.9	**53.9**	0	**p11**	1.4	4.3	19.3	**74.2**	0.8
p12	0.5	3.4	25.4	**67.3**	3.4	**p12**	1.8	4.8	28.8	**64.6**	0	**p12**	1.2	4.6	23.3	**70.1**	0.8
p13	0.7	3.8	31.2	**60.3**	4.0	**p13**	1.2	4.0	24.4	**70.4**	0	**p13**	0.6	4.0	24.9	**70.0**	0.5
p14	1.6	9.2	39.6	**45.4**	4.2	**p14**	4.7	8.3	26.0	**61.0**	0	**p14**	4.6	13.6	33.7	**47.0**	1.1
s15	4.6	23.0	45.5	**21.3**	5.6	**s15**	**22.0**	36.6	26.9	14.5	0	**s15**	6.0	23.0	41.3	**28.8**	0.9
s16	**21.3**	34.2	27.5	10.4	6.6	**s16**	**34.7**	26.2	31.5	7.6	0	**s16**	**26.5**	32.5	28.7	11.2	1.1
s17	5.0	12.1	40.8	**37.5**	4.6	**s17**	14.9	19.5	30.4	**35.2**	0	**s17**	6.4	10.9	28.6	**53.0**	1.1
s18	12.9	36.1	32.0	12.3	6.7	**s18**	23.7	21.2	24.3	**30.8**	0	**s18**	2.8	11.9	29.3	**55.1**	0.9
s19	9.5	26.0	41.4	17.0	6.1	**s19**	**37.9**	20.8	24.8	16.5	0	**s19**	8.0	21.0	36.6	**33.3**	1.1

Reliability of CASP scales

Table 6 shows the Cronbach's alpha coefficients for the four CASP scales. CASP-19 scale presented acceptable to good internal consistency coefficients. Cronbach alpha of CASP-19 total score was 0.84 (Czech Republic) 0.83 (Russia) and 0.86 (Poland). Nearly all CASP domains had high internal consistency. Self-realisation domain had respectable reliability, with coefficient alpha ranging from 0.73 to 0.75. The pleasure subscale was found to be highly reliable (α = 0.78, α =0.74, α =0.75 for Czech Republic, Russia and Poland respectively). However, autonomy domains had particularly low reliability coefficients, which suggested unacceptable reliability. When the control and autonomy domains were combined together to form the 12-item scale, alpha coefficient for the domain rose to 0.56, 0.68 and 0.63 (CASP12v1) and 0.58, 0.69 and 0.68 (CASP12v2) for Czech Republic, Russia and Poland respectively. The CASP12v3 score and its subscales had high reliability coefficients varying between 0.76 and 0.80 for the three HAPIEE samples. With the exception of Control/Autonomy domain in the Czech Republic (α = 0.64), all subscale coefficients were close to or above 0.70.

Table 6 Cronbach's Alpha Coefficient of internal consistency reliability

	Czech Republic	Russia	Poland
CASP-19 Total score	0.84	0.83	0.86
Control	0.47	0.63	0.62
Autonomy	0.53	0.58	0.57
Pleasure	0.78	0.72	0.78
Self-realisation	0.73	0.74	0.75
CASP12v1 Total score	0.78	0.74	0.79
Control+Autonomy	0.56	0.68	0.63
Pleasure	0.74	0.57	0.69
Self-realisation	0.72	0.70	0.73
CASP12v2 Total score	0.80	0.77	0.82
Control+Autonomy	0.58	0.69	0.68
Pleasure	0.78	0.66	0.79
Self-realisation	0.77	0.70	0.73
CASP12v3 Total score	0.76	0.76	0.80
Control+Autonomy	0.64	0.71	0.72
Self-realisation+Pleasure	0.75	0.69	0.72

Moreover, each item of CASP-19 was correlated with total scores for both its own domain and the other three domains. All 19 items had high correlations with their respective domains (See Table 7).

Table 7 Spearman's correlations between CASP items and domains for Czech Republic, Russia, and Poland.

Czech Republic					Russia					Poland				
Item	Control	Autonomy	Pleasure	Self-realisation	Item	Control	Autonomy	Pleasure	Self-realisation	Item	Control	Autonomy	Pleasure	Self-realisation
1	**0.647**	0.417	0.160	0.239	1	**0.746**	0.426	0.173	0.256	1	**0.731**	0.439	0.251	0.258
2	**0.619**	0.235	0.142	0.186	2	**0.741**	0.426	0.170	0.169	2	**0.769**	0.379	0.327	0.308
3	**0.621**	0.359	0.328	0.435	3	**0.611**	0.332	0.301	0.399	3	**0.549**	0.406	0.316	0.463
4	**0.618**	0.379	0.354	0.295	4	**0.652**	0.355	0.116	0.112	4	**0.638**	0.336	0.350	0.275
5	0.353	**0.639**	0.343	0.389	5	0.423	**0.712**	0.394	0.317	5	0.447	**0.681**	0.326	0.374
6	0.204	**0.535**	0.116	0.084	6	0.182	**0.589**	0.160	-0.104	6	0.181	**0.519**	0.071	-0.003
7	0.324	**0.557**	0.467	0.427	7	0.292	**0.602**	0.436	0.121	7	0.379	**0.520**	0.498	0.397
8	0.439	**0.606**	0.167	0.293	8	0.475	**0.615**	0.219	0.331	8	0.478	**0.680**	0.251	0.364
9	0.308	**0.612**	0.179	0.252	9	0.389	**0.549**	0.106	0.192	9	0.292	**0.589**	0.218	0.288
10	0.274	0.269	**0.657**	0.422	10	0.117	0.202	**0.698**	0.312	10	0.304	0.283	**0.649**	0.382
11	0.349	0.303	**0.765**	0.519	11	0.215	0.285	**0.766**	0.468	11	0.362	0.282	**0.696**	0.445
12	0.285	0.330	**0.694**	0.451	12	0.291	0.461	**0.727**	0.275	12	0.371	0.383	**0.708**	0.456
13	0.161	0.164	**0.583**	0.273	13	0.218	0.378	**0.665**	0.189	13	0.247	0.242	**0.614**	0.351
14	0.287	0.306	**0.741**	0.501	14	0.160	0.251	**0.659**	0.248	14	0.338	0.324	**0.783**	0.572
15	0.397	0.404	0.488	**0.707**	15	0.429	0.329	0.324	**0.692**	15	0.457	0.450	0.499	**0.742**
16	0.030	0.034	0.109	**0.461**	16	0.146	0.054	0.217	**0.573**	16	0.123	0.142	0.181	**0.585**
17	0.355	0.396	0.588	**0.699**	17	0.224	0.299	0.486	**0.656**	17	0.346	0.322	0.557	**0.692**
18	0.355	0.352	0.487	**0.783**	18	0.228	0.179	0.342	**0.756**	18	0.377	0.313	0.523	**0.680**
19	0.422	0.412	0.523	**0.779**	19	0.192	0.089	0.329	**0.761**	19	0.387	0.345	0.544	**0.767**

Correlations between CASP-19 and physical functioning, self-rated health, CES-D20: evidence for construct validity

The associations of CASP-19 dimensions with physical functioning scales, self-rated health, CES-D20 are shown in Table 8. Physical functioning (SF-10) and self-rated health scores were moderately correlated with total CASP-19 score in each country. These findings indicated that as the level of physical functioning increases, the quality of life score increases. Conversely, the level of quality of life decrease with increasing levels of depressive symptoms and poor sel-rated health. All correlations were significant at $p<0.001$ (Table 8).

Table 8 Correlation coefficients of the CASP-19 dimensions with Physical functioning (SF-10), Self-rated health, CESD-20 Depression scale

	Czech Republic			Russia			Poland		
	SF-10	**Self-rated health**	**CES-D 20**	**SF-10**	**Self-rated health**	**CES-D 20**	**SF-10**	**Self-rated health**	**CES-D 20**
CASP-19 Total scale	0.40	-0.41	-0.49	0.40	-0.37	-0.40	0.41	-0.37	-0.57
Control	0.32	-0.31	-0.39	0.34	-0.30	-0.34	0.34	-0.28	-0.47
Autonomy	0.35	-0.34	-0.34	0.34	-0.32	-0.21	0.38	-0.33	-0.39
Self-realisation	0.35	-0.38	-0.40	0.32	-0.27	-0.41	0.36	-0.33	-0.49
Pleasure	0.24	-0.27	-0.41	0.18	-0.20	-0.20	0.22	-0.24	-0.50

All correlations were significant at $P < 0.001$

Spearman's correlation coefficients are interpreted as follows: 0.90> excellent relationship, 0.90, 0.90-0.71= Good, 0.70-0.51=Fair, 0.51-0.31=Weak, 0.30≤ none.

Confirmatory factor analysis of CASP-19 and three 12-item scales of CASP

Table 9 presents the goodness of fit indices for the three measurement models in each country. The four-factor solutions for CASP-19 had relatively poor model fit, as illustrated by the goodness of fit indices. RMSEA values were all above or equal to 0.10; CFI and TLI values were below 0.90. Although the three-factor second-order model suggested the best fit of all three models, the fit indices indicted only an acceptable model in the Czech and Polish samples (Czech Republic: CFI= 0.96, TLI=0.94, RMSEA=0.08; Poland: CFI=0.96, TLI=0.95, RMSEA=0.07 for CASP12v2) and a marginal model fit for Russia (CASP12v2: CFI= 0.86, TLI=0.82, RMSEA=0.16).

In addition to the established measurement models, a model composed of control/autonomy and self-realisation/pleasure factors which included error correlations between negative items were tested (see table 10). Two-factor model of CASP12v3 was good fit to the data in Czech Republic (CFI=0.98, TLI=0.97, RMSEA = 0.05, WRMR=1.65) and satisfactory model fit in Poland and Russia (Poland CFI=0.96, TLI=0.94, RMSEA = 0.07 WRMR= 2.70; Russia CFI=0.93, TLI=0.90, RMSEA = 0.08, WRMR= 3.04) Goodness-of-fit indices for the two-factor structure was substantially better than the second-order models. Similarly, the single-factor measurement model provided a good fit to the data, suggesting that either single factor or two factor models fit the data equally well.

For two-factor measurement models of CASP12v3, all item factor loadings were significant ($p<0.001$). Items on the self-realisation/pleasure exhibited strong factor

loadings (>0.40) for all three samples. Four items (C1 C2 A8, A9) were below the 0.4 level in the Czech sample (Figure 12), whereas two items did not reach the recommended 0.4 threshold in the Russian and Polish samples (Items C4, A9 and items C1 and A9 in Russian and Poland respectively) (see Figures 13 and 14). Item C1 “My age prevents me from doing the things I would like to do” and A9 “Shortage of money stops me from doing the things I want to do” exhibited lower factor loadings than other items among all samples (Czech Republic 0.28, 0.31; Russia 0.41, 0.34; Poland 0.37 0.38 for C1). Moreover, the correlation between the control/autonomy and self-realisation/pleasure factors were significant and very high (Czech Republic, r=0.89; Russia, r=0.74; Poland, r=0.85). This indicated that there may be only one factor underlying the 12-items scale.

Table 9 Goodness-of-fit indices for the 3 measurement models for CASP-19, CASP12v1, CASP12v2 in the HAPIEE wave1

	Czech Republic			Russia			Poland		
Measures	**CFI**	**TLI**	**RMSEA**	**CFI**	**TLI**	**RMSEA**	**CFI**	**TLI**	**RMSEA**
CASP-19									
Single factor model	0.86	0.85	0.10	0.73	0.69	0.15	0.85	0.83	0.11
1st order model : 4-Factor	0.90	0.88	0.09	0.83	0.80	0.12	0.89	0.87	0.10
2nd order model: 4-Factors	0.88	0.86	0.10	0.81	0.78	0.12	0.87	0.85	0.10
CASP12v1									
Single factor model	0.92	0.90	0.09	0.69	0.62	0.17	0.89	0.86	0.11
1st order model: 3-Factors	0.96	0.95	0.07	0.89	0.84	0.11	0.96	0.94	0.08
2nd order model: 3-Factors	0.95	0.93	0.08	0.83	0.78	0.13	0.94	0.92	0.08
CASP12v2									
Single factor model	0.93	0.91	0.09	0.72	0.66	0.17	0.90	0.88	0.11
1st order model: 3-Factors	0.88	0.84	0.12	0.88	0.84	0.12	0.96	0.95	0.07
2nd order model: 3-Factors	0.96	0.94	0.08	0.86	0.82	0.13	0.96	0.95	0.07

CFI = comparative fit index, values >0.90 indicate good fit; TLI = Tucker-Lewis index, values >0.90 indicate good fit; RMSEA = root mean square error of approximation values <0.05 indicate good fit.

Table 10 Goodness-of-fit indices for the Two-factor model with correlated errors for negative items in the HAPIEE wave 1.

	Czech Republic				Russia				Poland			
Measures	**CFI**	**TLI**	**RMSEA**	**WRMR**	**CFI**	**TLI**	**RMSEA**	**WRMR**	**CFI**	**TLI**	**RMSEA**	**WRMR**
CASP-19:1-factor	0.94	0.93	0.07	2.89	0.80	0.79	0.13	5.69	0.90	0.88	0.09	4.62
CASP-19: 2-factors	0.95	0.94	0.07	2.68	0.83	0.79	0.12	5.30	0.92	0.89	0.09	4.28
CASP12v1: 1-factor	0.95	0.93	0.07	2.69	0.85	0.72	0.13	5.05	0.93	0.91	0.09	3.87
CASP12v1: 2-factors	0.96	0.94	0.07	2.43	0.87	0.82	0.11	4.30	0.95	0.93	0.08	3.31
CASP12v2:1-factor	0.95	0.94	0.08	2.72	0.84	0.78	0.14	5.27	0.94	0.92	0.08	3.74
CASP12v2: 2-factors	0.96	0.94	0.08	2.55	0.86	0.81	0.13	4.76	0.95	0.93	0.09	3.52
CASP12v3: 1-factor	0.98	0.96	0.05	1.79	0.91	0.87	0.09	3.50	0.95	0.93	0.07	3.02
CASP12v3: 2-factors	0.98	0.97	0.05	1.65	0.93	0.90	0.08	3.04	0.96	0.94	0.07	2.70

CFI = comparative fit index, values >0.90 indicate good fit; TLI = Tucker-Lewis index, values >0.90 indicate good fit; RMSEA = root mean square error of approximation, values <0.05 indicate good fit.

Figure 12 CASP12v3 two-factor measurement model with standardized loadings for Czech Republic

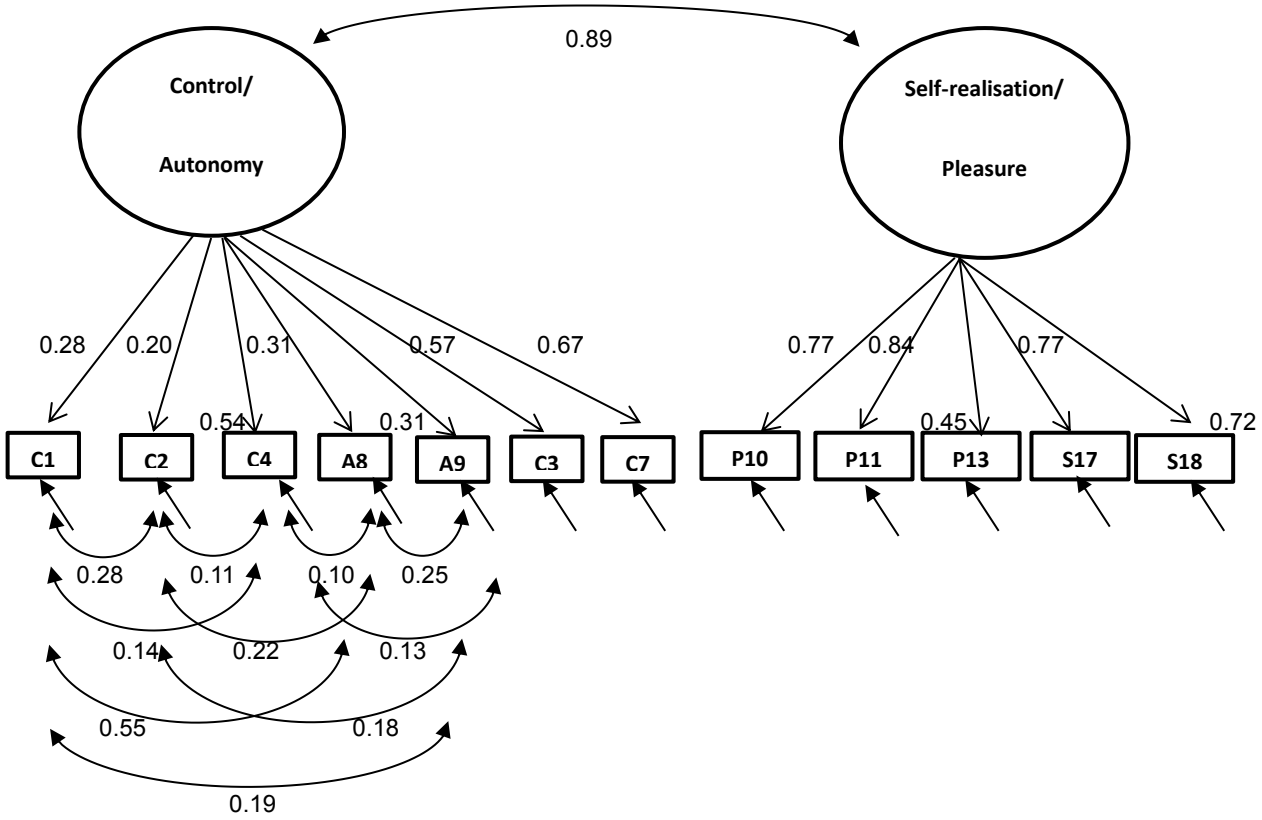


Figure 13 CASP12v3 Two-factor measurement model with standardized loadings for Russia.

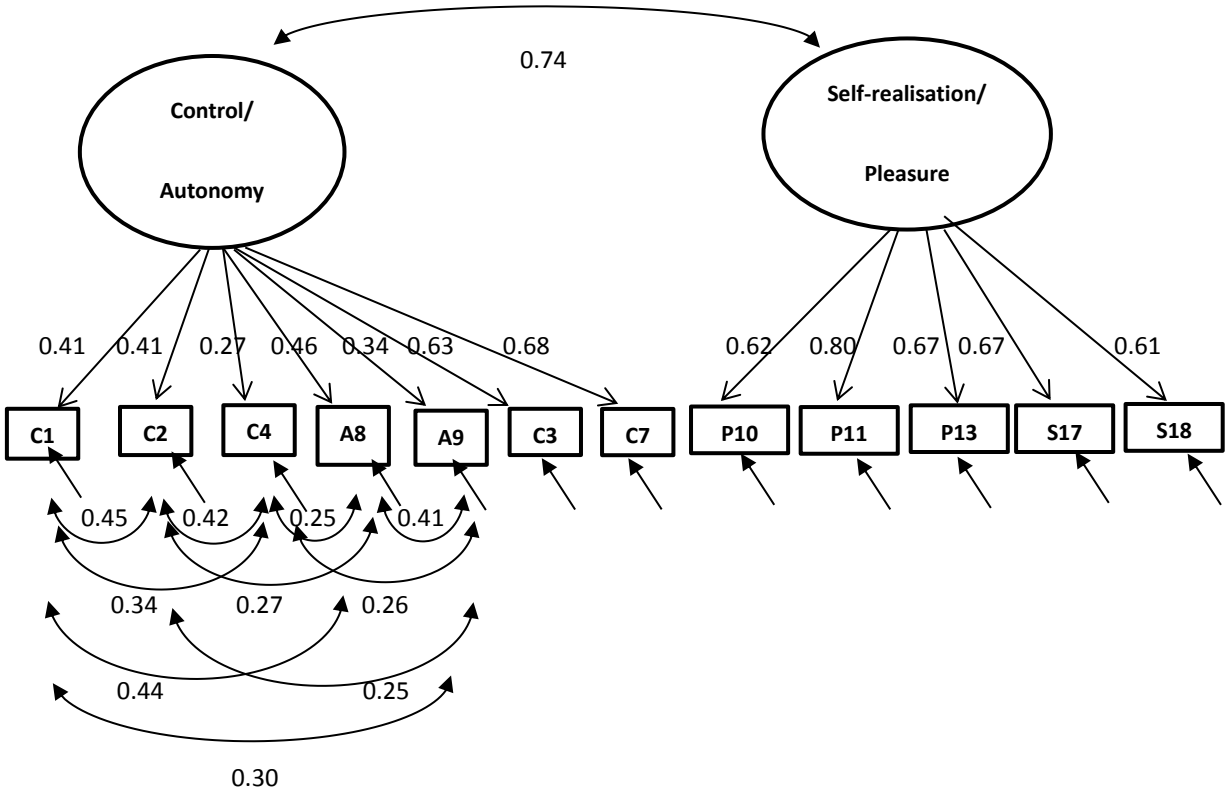
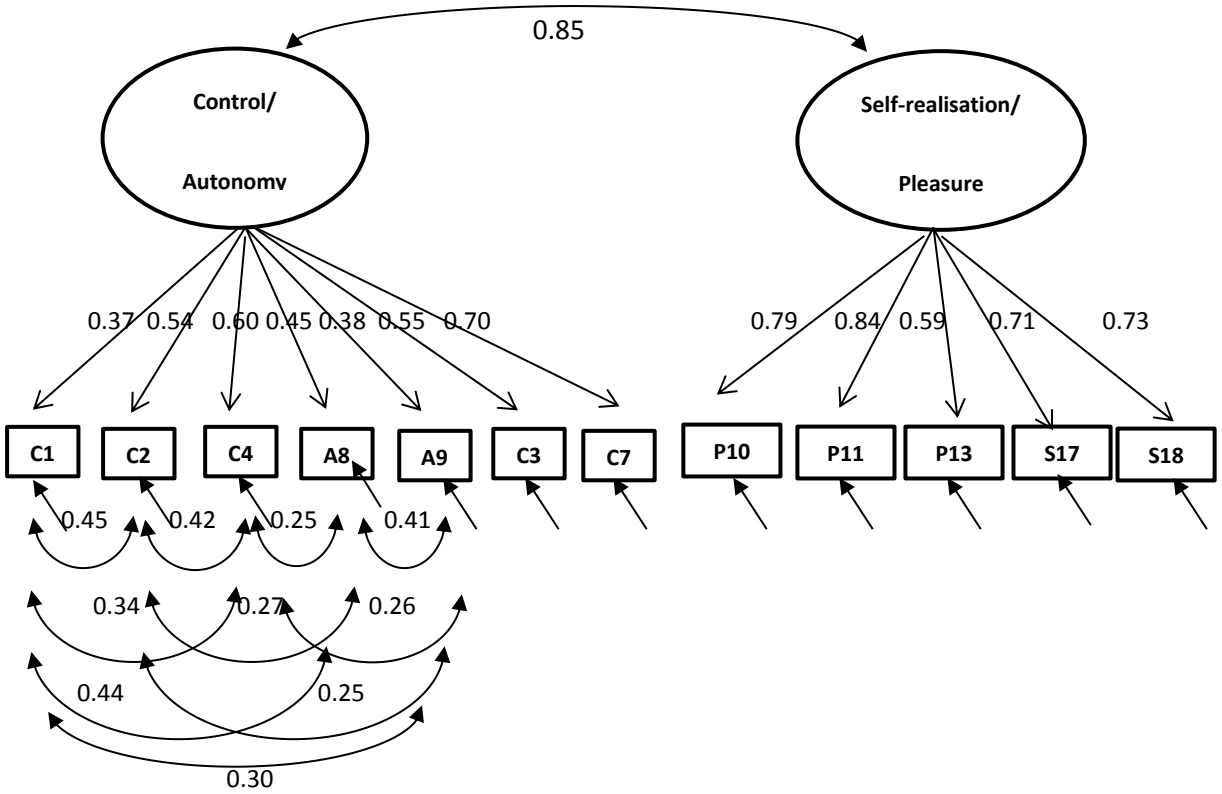


Figure 14 CASP12v3 Two-factor measurement model with standardized loadings for Poland.



To summarize, the findings presented in **Chapter 5.*2*** have addressed the one of the subsidiary research objective – the psychometric validation of the CASP instrument across HAPIEE samples. Confirmatory factory analysis revealed that the second-order four-factor model of the original CASP-19 does not provide a good fit to the data. Two-factor model of CASP12v3 including residual covariances for negative items to account for the method effect of negative items had the best fit to the data in all three HAPIEE populations. Overall, the results of this chapter have demonstrated that the CASP12v.3 is a valid and reliable tool for assessing QOL among adults aged 50 years or older. This version of CASP is recommended for use in future studies investigating QOL in the CEE populations. The next chapters will investigate predictors and prognostic ability of the CASP instrument in predicting all-cause mortality using CASP12v3 score.

5.3 Key predictors of quality of life in HAPIEE: influence of socio-demographic factors, health and behavioural risk factors and social relationships on CASP12v3

In this chapter, the strength of the associations between baseline levels of quality of life, captured by the CASP12v3 instrument, and different socio-demographic, psychosocial, behavioural risk factors and physical health variables are explored across HAPIEE samples.

Because men had significantly higher mean score on the CASP-19 than women in the descriptive analysis, separate regression models were fitted for men and women in each cohort. The first step consisted of simple univariable analysis to decide the variables that would be used to predict CASP12v3 scores. All variables that were significantly associated with CASP12v3 at $p<0.05$ were then used as determinants. In the unadjusted univariable linear regression analyses, age, marital status, education, material deprivation, occupational status, mean BMI, poor health status, and long-term health problems were all significantly associated with CASP-19 scores in all three HAPIEE samples. Regarding frequency of contact with relatives and friends, having frequent contact with friends and relatives were also significantly associated with higher CASP scores.

Next, hierarchical regression models were constructed by sequentially adding predictors in five blocks. Regression coefficients and R-squared (explained variance R2) for the stepwise hierarchical multivariable linear regression analysis are shown in Tables 11 to 13. As can be seen, Model 1, with age as the only predictor variables, did not account for significant variance in CASP-19. There were statistically significant associations between age and CASP12v3 in all

populations except for Polish women (Table 13). In Czech Republic, (Table 11, figure 15 and 16) and Russia (Table 12), a one unit (one year) increase in age was associated with about a 0.10 unit decrease in CASP12v3 scores. In contrast, age was positively associated with age, with increasing values by 0.05 units for every one unit increase among Polish men (Table 13). In addition to age, Model 2 included a quadratic term, age-squared, in order to indicate a quadratic relationship between age and CASP-19. This regression model confirmed the results of the descriptive analysis (Section 5.1 Table 3) that quality of life reaches a peak before 65 years and start to decrease thereafter. The coefficient of age-squared term in model 2 was statistically significant for Russia and Poland in both genders (Table 12, Table 13). These results indicated that the relationship between age and CASP12v3 score is not linear. In these samples, this model accounted for an in increasing variance in CASP12v3, as indicated by an increase in R-squared. The positive coefficient for age and the negative one for age-squared term indicate a monotonic increasing function of CASP12v3 by age until a peak is reached, after which quality of life starts to decline. In Russian men, quality of life increased from 50 years old to peak at 59 years (Figure 17). From there it gradually started to decline. Quality of life reached its peak at 58 years among Russian women (Figure 18). In the Polish data, quality of life initially increased from age 50 to peak at 64 years for men (Figure 19). It then started to decrease thereafter. CASP12v3 scores reached its maximum at 61 years among Polish women (Figure 20).

Figure 15 Relationship between CASP12v3 score and age among Czech men

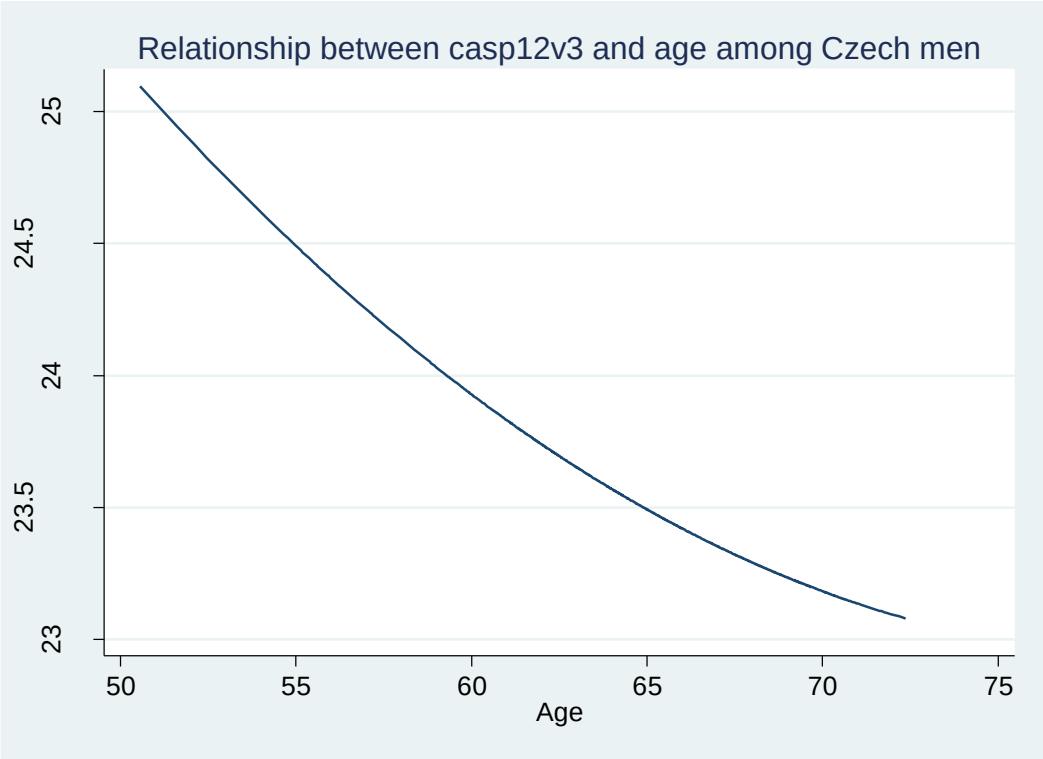


Figure 16 Relationship between CASP12v3 score and age among Czech women

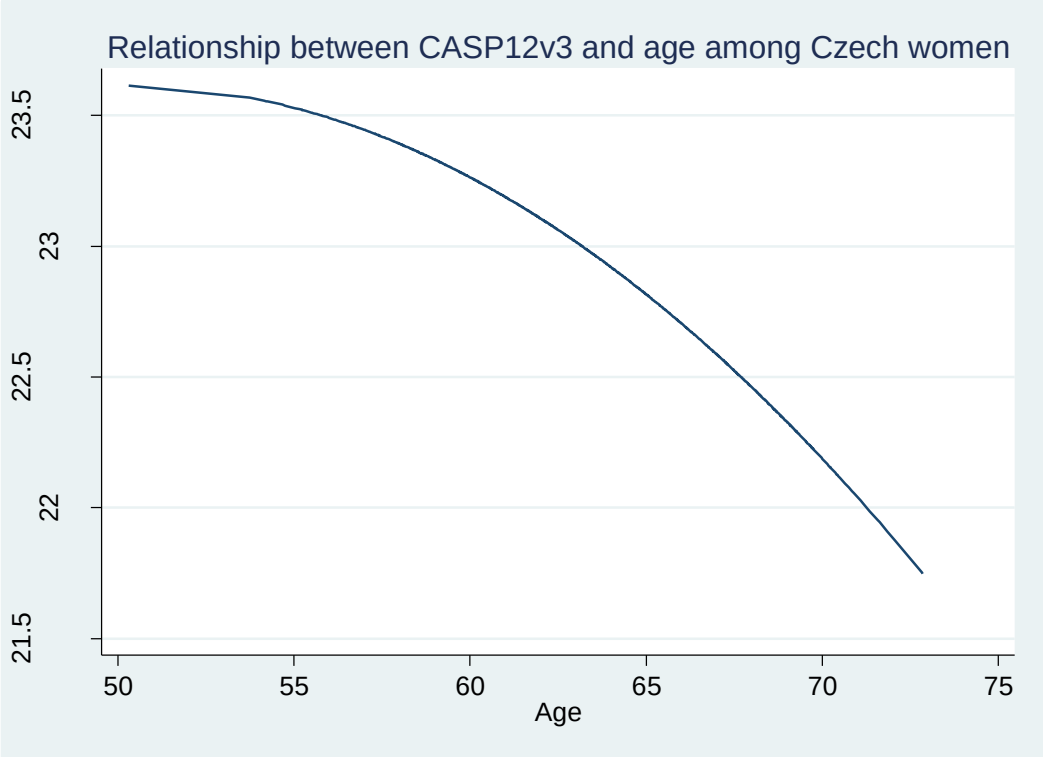


Figure 17 Age curve for quality of life among Russian men

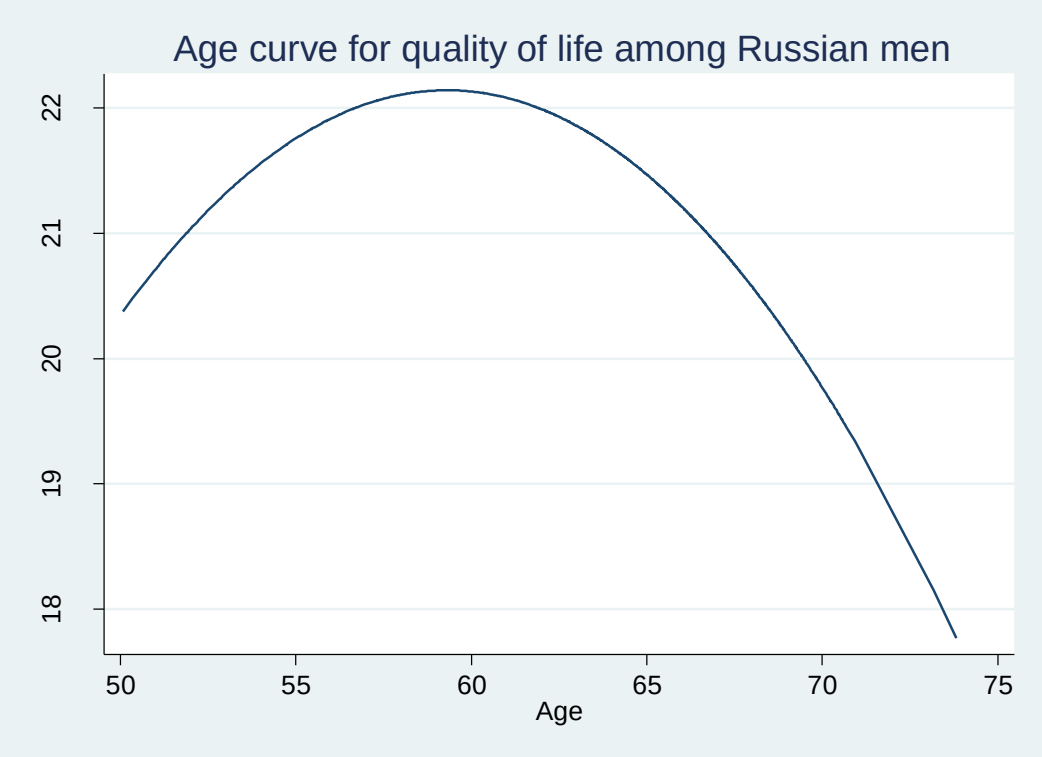


Figure 18 Age curve for quality of life among Russian women

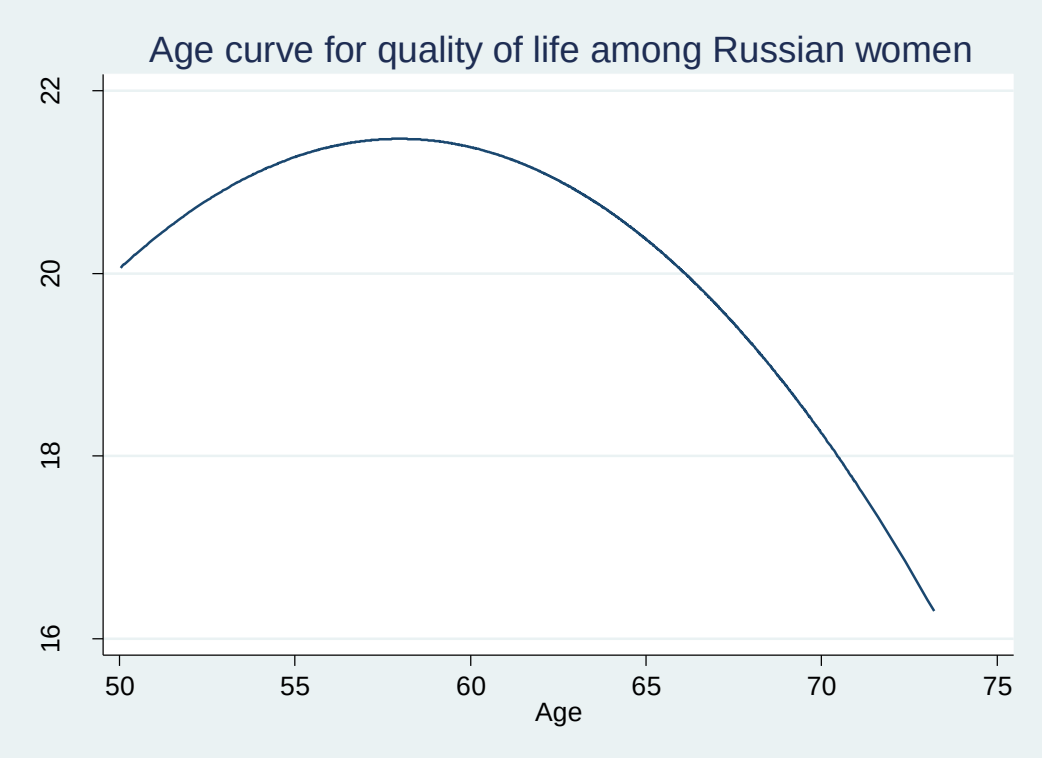


Figure 19 Age curve for quality of life among Polish men

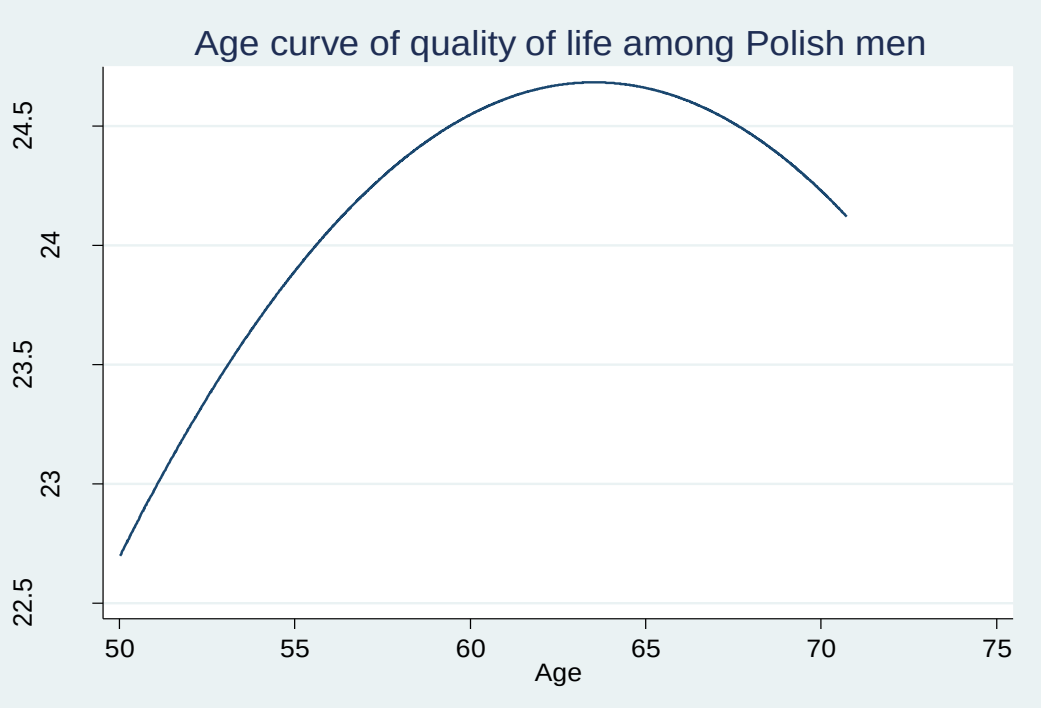
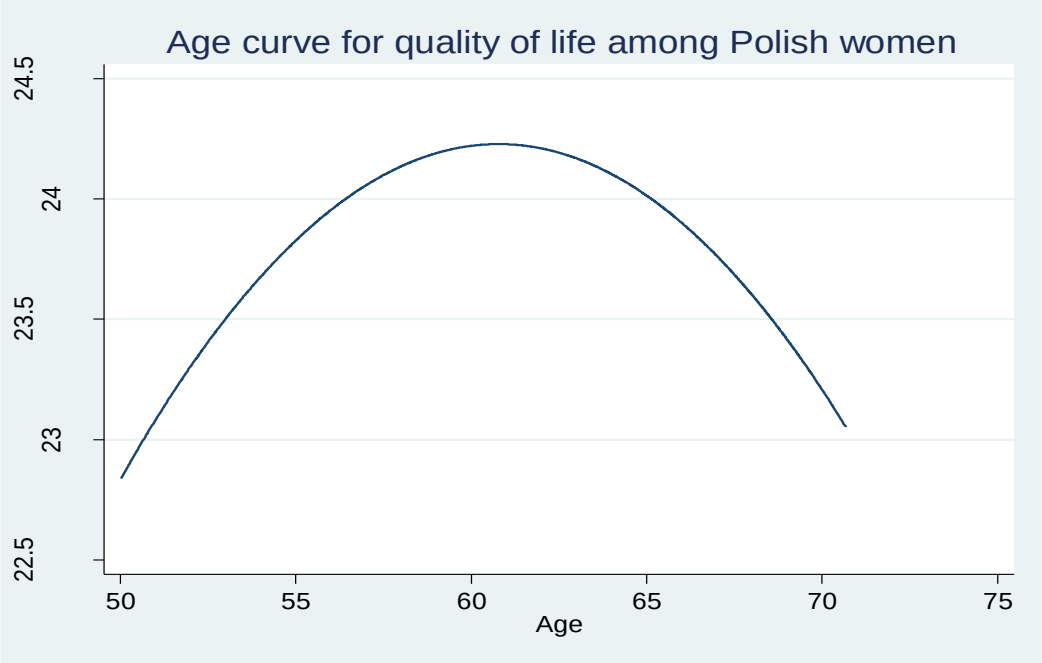


Figure 20 Age curve for quality of life among Polish women



Model 3 included age, age-squared, marital status and socio-economic variables (Education level, household amenities, material deprivation, occupational status and years in retirement). The results indicated that material deprivation score is a strong predictor of CASP12v3 score, with the other variables in the model held constant. Higher scores of material deprivation were associated with lower CASP12v3 scores. Among men, the variables explained 17.2% to 22.9% the variances in CASP12v3 scores as indicated by the R-squared values; for women, it was between 15.0% to 20.5%.

Inclusion of health and lifestyle risk variables in model 4 substantially improved model fit. These variables accounted for additional variance in quality of life, with large increases in R-squared over model 3. A relatively high R-squared values for both genders indicated that depressive symptoms and physical health variables explained much of the effect on quality of life in each cohort.

The final multivariable model (Model 5), comprising of age, age-squared term, marital status and socio-economic variables (education level, household amenities, material deprivation, occupational status and years in retirement), as well as depressive symptoms, physical health variables and social network variables, accounted for the most variance in CASP12v3 scores. Among men, the variables explained 35.1% to 41.5% of the variances in quality of life as indicated by the R-squared values; for women, it was between 33.4% to 42.6%.

Also, a model including an interaction term between sex and total CASP12v3 and all other covariates were fitted for all participants combined. This model fit significantly better than a model without this interaction term for gender (p-values<0.001) further supporting the study finding that the relationship between CASP and covariates differed between men and women.

Table 11 Regression coefficient and R-squared for multivariable regression analysis using CASP12v3 as dependent variable (Czech Republic)

Czech Republic	Men					Women				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	28.76	39.01	71.71	64.18	51.50	29.00	14.52	28.36	30.50	37.35
Age	**-0.08**	-0.40	-1.33	-1.08	-0.83	**-0.10**	0.36	-0.06	-0.18	-0.47
Age squared		0.003	0.01	0.01	0.01		-0.004	0.001	0.002	0.004
Marital status (married cohabiting)										
Single			**-3.28**	**-2.63**	-2.12			-0.92	-0.49	-0.79
Divorced			-0.33	-0.25	-0.33			**-1.00**	**-1.14**	**-1.29**
Widowed			0.89	0.91	0.59			**-0.88**	**-0.61**	**-0.93**
Education (Primary)										
Vocational			-0.64	-1.12	-0.89			0.03	-0.44	-0.41
Secondary			-0.01	-0.91	-0.63			**0.72**	-1.17	-0.13
University			0.03	-0.75	-0.42			**1.24**	0.16	0.24
Household amenities (Bottom tertile; poorest)										
Middle tertile			0.32	0.68	0.25			-0.37	-0.16	-0.23
Top tertile (Riches)			0.44	0.45	0.28			-0.22	-0.22	-0.32
Material deprivation score (Low)										
Medium (1-6)			**-3.15**	**-2.43**	**-2.36**			**-2.75**	**-2.06**	**-2.00**
High (7-12)			**-6.67**	**-4.51**	**-4.36**			**-5.91**	**-3.91**	**-3.72**
Employment status (Non-working)										
Working			**-1.23**	**-0.87**	**-0.91**			**-1.35**	**-0.92**	**-1.01**
Years in retirement			**-0.14**	**-1.00**	-0.09			**-0.12**	-0.08	-0.09

Table 11. (Continued)	Men					Women				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Self-rated health status (Very good & Good)										
Average				**-1.95**	**-1.89**				**-1.65**	**-1.53**
Poor and very poor				**-3.04**	**-3.01**				**-2.95**	**-2.75**
Long-term health problems (No)										
Yes				**-1.05**	**-1.00**				-0.33	-0.44
Physical functioning score (Lowest; worst)										
Middle				0.19	0.08				**0.89**	**0.92**
Highest (Best)				**1.47**	**1.40**				**2.14**	**2.07**
Depressive symptoms (No)										
Yes				**-3.53**	**-3.33**				**-3.11**	**-3.08**
Mean BMI				-0.01	-0.01				0.05	0.05
Physical activity (no. of hours)				0.01	0.02				0.03	0.02
Frequency of contact with relatives (No relatives)										
Less than once a month					1.68					0.26
Once a month or more					1.72					1.28
Once a week or more					2.53					**1.89**
Frequency of contact with friends (No friends)										
Less than once a month					**2.80**					1.16
Once a month or more					**3.03**					0.98
Once a week or more					**3.77**					1.27
R-squared	0.003	0.003	0.172	0.351	0.382	0.01	0.006	0.150	0.335	0.352
Change in R2		0	0.169	0.179	0.031		0.004	0.144	0.185	0.017

Note: Boldface indicates significance. Model 1 only included age. Model 2 was adjusted for age and age-squared. Model 3 was additionally adjusted for marital status and socioeconomic position (Education, household amenities score, and material deprivation). Model 4 was additionally adjusted for mental/physical health and lifestyle risk factors. Final model (Model 5) included all the variables from the previous models plus frequency of contact with friends and relatives.

Table 12 Regression coefficient and R-squared for multivariable regression analysis using CASP12v3 as dependent variable (Russia)

Russia	Men					Women				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	27.79	-50.79	-21.09	21.52	17.43	31.33	-53.55	-32.08	-2.67	-4.66
Age	**-0.10**	**2.46**	**1.57**	0.18	0.24	**-0.17**	**2.59**	**1.86**	0.93	**0.98**
Age squared		**-0.02**	**-0.01**	-0.002	-0.003		**-0.02**	**-0.02**	-0.01	**-0.01**
Marital status (married cohabiting)										
Single			-1.94	**-2.06**	**-1.83**			-0.35	-0.18	-0.17
Divorced			-1.11	-1.03	**-1.15**			-0.60	-0.32	-0.35
Widowed			-1.05	**-1.33**	**-1.51**			-0.12	0.01	0.01
Education (Primary)										
Vocational			0.05	0.02	-0.07			**0.66**	**0.74**	**0.71**
Secondary			-0.44	-0.33	-0.33			0.35	**0.70**	**0.70**
University			**1.05**	0.53	0.48			**1.36**	**1.17**	**1.15**
Household amenities (Bottom tertile; poorest)										
Middle tertile			-0.26	0.32	0.06			-0.15	0.23	0.18
Top tertile (Richest)			**1.35**	**1.56**	**1.25**			**0.78**	**1.24**	**1.15**
Material deprivation score (Low)										
Medium (1-6)			**-2.94**	**-2.66**	**-2.76**			**-2.57**	**-2.06**	**-2.13**
High (7-12)			**-5.25**	**-4.26**	**-4.25**			**-4.91**	**-4.02**	**-4.01**
Years in retirement			-0.03	-0.01	0.001			**-0.14**	**-0.10**	**-0.10**

Table 12. (Continued)	Men					Women				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Self-rated health status (Very good & Good)										
Average				**-1.27**	**-1.11**				**-2.81**	**-2.86**
Poor and very poor				**-3.24**	**-3.04**				**-4.50**	**-4.55**
Long-term health problems (No)										
Yes				**-0.77**	**-0.86**				**-0.54**	**-0.56**
Physical functioning score (Lowest; worst)										
Middle				**1.88**	**1.92**				**1.12**	**1.11**
Highest (Best)				**3.16**	**3.15**				**2.04**	**1.97**
Depressive symptoms (No)										
Yes				**-2.95**	**-2.66**				**-2.17**	**-2.08**
Mean BMI				-0.02	0.02				0.01	0.01
Physical activity (no. of hours)				**0.20**	**0.20**				**0.19**	**0.19**
Frequency of contact with relatives (No relatives)										
Less than once a month					0.57					-0.18
Once a month or more					1.07					0.10
Once a week or more					1.19					-0.03
Frequency of contact with friends (No friends)										
Less than once a month					0.92					**0.87**
Once a month or more					**1.61**					**1.07**
Once a week or more					**1.60**					**1.37**
R-squared	0.005	0.005	0.173	0.404	0.415	0.020	0.028	0.159	0.329	0.334
Change in R2		0	0.168	0.231	0.011		0.008	0.131	0.170	0.005

Note: Boldface indicates significance. Model 1 only included age. Model 2 was adjusted for age and age-squared. Model 3 was additionally adjusted for marital status, and soci oeconomic position (Education, household amenities score, and material deprivation). Model 4 was additionally adjusted for mental/physical health and lifestyle risk factors. Final model (Model 5) included all the variables from the previous models plus frequency of contact with friends and relatives.

Table 13 Regression coefficient and R-squared for multivariable linear regression analysis using CASP12v3 as dependent variable (Poland)

Poland	Men					Women				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	21.46	-19.19	15.43	25.85	23.66	24.28	-20.08	18.78	31.37	25.85
Age	**0.05**	**1.38**	0.35	0.02	0.05	-0.01	**1.46**	0.24	-0.19	-0.11
Age squared		**-0.01**	-0.003	-0.0004	-0.001		**-0.01**	-0.001	0.001	0.001
Marital status (married cohabiting)										
Single			-0.33	-0.69	-0.73			-0.49	-0.69	**-0.81**
Divorced			**-1.43**	-0.73	-0.86			**-1.33**	**-0.94**	**-0.97**
Widowed			-0.44	0.03	-0.17			**-0.81**	**-0.91**	**-1.06**
Education (Primary)										
Vocational			**0.90**	**0.64**	0.59			**1.04**	**0.85**	**0.82**
Secondary			0.56	0.05	0.02			**1.04**	**0.90**	**0.80**
University			**0.85**	0.59	0.60			**1.05**	**0.79**	**0.71**
Household amenities (Bottom tertile; poorest)										
Middle tertile			**1.62**	**0.61**	**0.65**			**0.82**	0.27	0.27
Top tertile (Richest)			**2.80**	**1.46**	**1.52**			**2.10**	**1.20**	**1.17**
Material deprivation score (Low)										
Medium (1-6)			**-2.66**	**-1.85**	**-1.79**			**-2.58**	**-1.53**	**-1.51**
High (7-12)			**-5.63**	**-3.91**	**-3.89**			**-6.67**	**-2.55**	**-2.46**
Employment status (Non-working)										
Working			**-1.42**	**-1.10**	**-1.10**			**-1.97**	**-1.60**	**-1.65**
Years in retirement			**-0.09**	**-0.04**	**-0.04**			**-0.09**	-0.03	-0.02

Table 13. (Continued)	Men					Women				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Self-rated health status (Very good & Good)										
Average				**-0.78**	**-0.75**				**-1.17**	**-1.20**
Poor and very poor				**-1.97**	**-1.94**				**-1.27**	**-2.17**
Long-term health problems (No)										
Yes				-0.05	-0.09				-0.42	-0.42
Physical functioning score (Lowest; worst)										
Middle				**1.19**	**1.15**				**0.95**	**0.97**
Highest (Best)				**2.43**	**2.38**				**2.27**	**2.29**
Depressive symptoms (No)										
Yes				**-3.95**	**-3.86**				**-4.17**	**-3.99**
Smoking (Never)										
Past				0.32	0.32				0.27	0.28
Current smoker				0.05	0.09				-0.01	0.08
Mean BMI				0.02	0.02				**0.07**	**0.07**
Physical activity (no. of hours)				**0.05**	**0.04**				0.07	0.07
Frequency of contact with relatives (No relatives)										
Less than once a month					0.03					**1.63**
Once a month or more					0.37					**1.83**
Once a week or more					0.76					**1.76**
Frequency of contact with friends (No friends)										
Less than once a month					0.48					**0.84**
Once a month or more					**1.01**					**1.38**
Once a week or more					**1.31**					**1.84**
R-squared	0.002	0.003	0.229	0.378	0.388	0	0.003	0.205	0.413	0.426
Change in R2		0.001	0.226	0.149	0.010		0.003	0.202	0.208	0.013

Note: Boldface indicates significance. Model 1 only included age. Model 2 was adjusted for age and age-squared. Model 3 was additionally adjusted for marital status, and socioeconomic position (Education, household amenities score, and material deprivation). Model 4 was additionally adjusted for Mental/physical health and lifestyle risk factors. Final model (Model 5) included all the variables from the previous models plus frequency of contact with friends and relatives.

Tables 14 to 16 display the standardized beta coefficients and 95% confidence interval for the multivariable regression analyses in each cohort, using the CASP12v3 score as the dependent variable. The standardized β coefficients are useful because they are independent of the original unit measure of predictor variables. Thus, a direct comparison can be made between variables.

In the multivariable linear regression analyses, it was found that self-rated health status, presence of long-term health problems, physical functioning, and symptoms of depression had great influence on quality of life, measured by the CASP12v3. With adjustment for other covariates, compared to males who reported very good or good health, those who reported poor and very poor health had significantly lower CASP12v3 scores (Regression coefficients: -3.01, 95% CI -4.23 to -1.79 (Czech Republic); -3.04, 95% CI -4.22 to -1.85 (Russia); -1.94, 95% CI -2.66 to -1.21 (Poland) Similar results were obtained for women with regression coefficients -2.75 (95% CI -3.73 to 1.78) for Czech Republic;-2.17 (95%CI -2.84 to -1.50) for Poland; and -4.55 (95% CI -5.77 to -3.33) among Russians.

CASP12v3 scores increased linearly with increasing physical functioning scores. Among women, those in the highest versus lowest tertile group of physical functioning score had significantly higher CASP12v3 scores; 2.07 (95% CI 1.31 to 2.84), 1.97 (95% CI 1.36 to 2.58), 2.29 (95% CI 1.71 to 2.87) for Czech Republic, Russia, Poland respectively. In men, the regression coefficients were 1.40 (95% CI 0.43 to 2.38); 3.15 (95%CI 2.34 to 3.97); 2.38 (95% CI 1.77 to 3.00) for Czech Republic, Russia, Poland respectively. The presence of long-term health problems was not a significant predictor of CASP12v3 scores among Czech women or the Polish samples. In the Czech Republic and Russia,

presence of long-term health problems could reduce CASP12v3 scores by approximately one unit among men (Czech men -1.01, 95% CI -1.64 to -0.38; Russia -0.86, 95% CI -1.46 to -0.26), while for women CASP12v3 scores could be reduced by half a unit in Russia (-0.56, 95% CI -0.98 to -0.14).

Having depressive symptoms had a strong effect on lowering quality of life scores (Regression coefficients for men : -3.33, 95% CI -4.30 to -2.36; -2.66, 95% CI -3.49 to -1.83; -3.86, 95% CI -4.38 to -3.33 for Czech Republic, Russia, Poland respectively). Similarly, women with depressive symptoms had statistically significantly lower quality of life compared with women without depressive symptoms (Czech Republic -3.08, 95% C I-3.66 to -2.51; Russia, -2.08, 95% CI -2.55 to -1.61; Poland -3.99, 95% CI -4.39 to -3.58).

Material deprivation was strongly associated with quality of life across all HAPIEE samples. For example, Russian participants in the highest tertile group of material deprivation had significantly lower CASP12v3 scores compared to those in the lowest tertile of material deprivation (Men -4.25, 95% CI -5.10 to -3.41; women -4.01, 95% CI -4.63 to -3.38; p for trend <0.001) (Table 15).

Education level was a significant predictor of CASP12v3 only for women in Russia (University level versus primary 1.15, 95% CI 0.47 to 1.82) and Poland (0.71, 95% CI 0.10 to 1.33). Household amenities score was a significant predictor of CASP12v3 among Russians and Poles (P for linear trend <0.001). In Russia, those in the highest tertile of household amenity level had significantly higher CASP12v3 scores compared to those in the lowest tertile of household amenity level (Men 1.25, 95% CI 0.42 to 2.08; Women 1.15, 95% CI 0.58 to 1.72)

(Table 15). In Poland, the regression coefficients for men was 1.53 (95% CI 0.93 to 2.12) and women 1.17 (95% CI 0.63 to 1.72) (Table 16).

Working after retirement improved quality of life. For example, among Czech men who were not working after retirement had significantly lower CASP12v3 score than those employed (-0.91, 95% CI -1.69 to -0.12). In Poland, the effect of unemployment on CASP12v3 was seen for both men women; non-working participants had significantly worse quality of life as compared to working participants (Men -1.10, 95% CI-1.70 to -0.49; Women 1.65, 95% CI 2.28 to -1.03) (Table 16).

Physical activity had a small but significant positive influence on quality of life in Russia and Poland in both genders; and among men only in the Czech Republic. For example, for a one unit increase in physical activity, we would expect around 0.20 unit increase in CASP12v3score, while adjusting for other covariates for Russian men and women. BMI had a statistically significant influence on QOL only among Polish women after controlling for all other risk factors.

Multivariable linear regression analyses revealed that frequency of contact with family was no longer significantly associated with CASP12v3 scores in Czech Republic and Russia, while in Poland, only women who were in contact with family at least once a week had significantly higher CASP12v3 scores compared to those without any relatives (1.76, 95% CI 0.86 to 2.66). For both men and women, frequency of contact with friends was independently associated with CASP12v3 after controlling for other covariates across countries; participants who were in contact with friends once a week or more had significantly higher CASP12v3 scores compared to those without any friends. In men, the regression

confidents were 3.77, 95% CI 2.09 to 5.46; 1.20, 95% CI -0.25 to 2.63; 1.32, 95% CI 0.49 to 2.14 for Czech Republic, Russia, and Poland respectively. In Women, the corresponding values were 1.89, 95% CI 0.38 to 3.40; 1.37, 95% CI 0.69 to 2. 04; 1.84, 95% CI 1.10 to 2.59 for Czech Republic, Russia, and Poland respectively.

Marital status had a significant influence on CASP12v3; widowed women in the Czech Republic (0.93, 95% CI -1.53 to -0.32) and Poland (-1.06, 95%CI -1.51 to -0.61) had statistically significant lower CASP12v3 scores than married/cohabiting participants. In Russia, marital status was significantly associated with CASP12v3 only in men (-1.51, 95% CI -2.53 to -0.49)

In contrast to the unadjusted analyses, the multivariable linear regression model showed that age is not significantly associated with CASP12v3 scores for Poland and Czech Republic. Nevertheless, a significant curvilinear relationship between age and CASP12v3 score was found among Russian women with regression coefficient for age 0.98 (95% CI-0.03 to 1.99) and age-squared term -0.01 (95% CI-0.02 to 0.001) (Table 15). Among Russian women, in the multivariable regression model adjusted for covariates, CASP12v3 scores increased from age 50 and declined after the age of 60. Thus, overall, the second hypothesis that there is a significant curvilinear relationship between CASP and age was only partially supported.

To summarize **Chapter 5.3**, the results illustrate that despite the variations in psychometric properties of CASP across different cohorts and datasets, factors that have previously been shown to relate to CASP in other studies also predict quality of life in HAPIEE.

In the univariable linear regression analyses, there was a significant negative relationship between age and CASP12v3 in the Czech Republic and a curvilinear relationship between with age in Poland and Russia. Behavioral risk factor such as smoking was not significantly associated with CASP12v3 score in the univariable analyses. In the multivariable regression analyses, a significant curvilinear relationship between age and CASP12v3 score was found among Russian women only. In HAPIEE data, quality of life in old age was reduced by depressive symptoms, poor self-rated health, and material deprivation. Higher household amenities score, working after retirement, higher physical functioning score and physical activity had significant positive influence on quality of life. Social relationships could have positive effects on quality of life; greater frequency of contacts with friends significantly raised CASP12v3 scores, whilst having frequent contact with family was also a significant positive predictor of quality of life among Polish women. Education level was a significant predictor of CASP12v3 scores only for women in Russia and Poland. Marital status also had a significant influence on CASP12v3 scores. Physical activity had a small but significant positive influence on quality of life, BMI was found to be a significant predictor of quality of life only in Poland.

Table 14 Beta coefficients for multivariable linear regression of CASP12v3 scores and predictors among Czech men and women

Czech Republic	Men		Women	
Variables	**Regression coefficient (95% CI)**	**β**	**Regression coefficient (95% CI)**	**β**
Constant	51.50		37.35	
Age	-0.83 (-2.69 to 1.03)	-0.58	-0.47 (-2.23 to 1.28)	-0.37
Age squared	0.01 (-0.01 to 0.02)	0.54	0.004 (-0.01 to 0.02)	0.41
Marital status (married cohabiting)				
Single	-2.12 (-4.54 to 0.30)	-0.04	-0.79 (-2.54 to 0.95)	-0.02
Divorced	-0.33 (-1.47 to 0.81)	-0.02	**-1.29 (-2.04 to -0.55)**	**-0.08**
Widowed	0.59 (-0.60 to 1.77)	0.03	**-0.93 (-1.53 to -0.32)**	**-0.07**
P linear for trend	0.63		**P<0.001**	
Education (Primary)				
Vocational	-0.89 (-2.07 to 0.29)	-0.09	-0.41 (-1.04 to 0.21)	-0.04
Secondary	-0.63 (-1.86 to 0.60)	-0.06	-0.13 (-0.77 to 0.50)	-0.01
University	-0.42 (-1.77 to 0.94)	-0.03	0.24 (-0.75 to 1.23)	0.01
P for linear trend	0.53		0.90	
Household amenities (Bottom tertile; Low amenity level)				
Middle tertile	0.25 (-0.42 to 0.93)	0.02	-0.23 (-0.77 to 0.31)	-0.02
Top tertile (High amenity level	0.28 (-0.42 to 0.98)	0.03	-0.32 (-0.93 to 0.29)	-0.03
P for trend	0.44		0.29	
Material deprivation score (Low)				
Medium (1-6)	**-2.36 (-2.94 to -1.78)**	**-0.22**	**-2.00 (-2.47 to -1.54)**	**-0.20**
High (7-12)	**-4.36 (-5.89 to -2.83)**	**-0.16**	**-3.72 (-4.88 to -2.55)**	**-0.14**
P for trend	**P<0.001**		**P<0.001**	
Employment status (Employed)				
Not Working	**-0.91 (-1.69 to -0.12)**	**-0.06**	-1.01 (-1.84 to -0.18)	-0.06
Years in retirement	-0.09 (-0.18 to 0.003)	-0.07	-0.09 (-0.20 to 0.02)	-0.08

Table 14. (Continued)	Men		Women	
	Regression coefficient (95% CI)	β	Regression coefficient (95% CI)	β
Self-rated health status (Very good & Good)				
Average	**-1.90 (-2.57 to -1.22)**	**-0.18**	**-1.53 (-2.09 to -0.98)**	**-0.15**
Poor and very poor	**-3.01(-4.23 to -1.79)**	**-0.17**	**-2.75 (-3.73 to 1.78)**	**-0.15**
P for linear trend	**P<0.001**		**P<0.001**	
Long-term health problems (No)				
Yes	**-1.01 (-1.64 to -0.38)**	**-0.09**	-0.44 (-0.98 to 0.11)	-0.04
Physical functioning score (Lowest; worst)				
Middle	0.08 (-0.77 to 0.92)	0.01	**0.92 (0.31 to 1.53)**	**0.09**
Highest (Best)	**1.40 (0.43 to 2.38)**	**0.13**	**2.07 (1.31 to 2.84)**	**0.19**
P for linear trend	**P=0.001**		**P<0.001**	
Depressive symptoms (No)				
Yes	**-3.33 (-4.30 to -2.36)**	**-0.19**	**-3.08 (-3.66 to -2.51)**	**-0.25**
Mean BMI	-0.01 (-0.08 to 0.06)	-0.01	0.05 (-0.002 to 0.09)	0.04
Physical activity (no. of hours)	**0.02 (-0.03 to 0.06)**	**0.02**	0.02 (-0.01 to 0.06)	0.03
Frequency of contact with family (No family)				
Less than once a month	1.68 (-0.94 to 4.29)	0.11	1.16 (-1.46 to 3.79)	0.05
Once a month or more	1.72 (-0.83 to 4.28)	0.15	0.98 (-1.53 to 3.48)	0.08
Once a week or more	2.53 (-0.01 to 5.06)	0.24	1.27 (-1.21 to 3.75)	0.12
P for linear trend	0.04		0.07	
Frequency of contact with friends (No friends)				
Less than once a month	**2.80 (1.13 to 4.48)**	**0.23**	0.26 (-1.29 to 1.81)	**0.02**
Once a month or more	**3.03 (1.38 to 4.68)**	**0.29**	1.28 (-0.22 to 2.78)	**0.13**
Once a week or more	**3.77 (2.09 to 5.46)**	**0.33**	**1.89 (0.38 to 3.40)**	**0.18**
P for linear trend	**P<0.001**		**P<0.001**	
R-squared	0.38		0.35	

Note: Boldface indicates significant result. Multivariable model included age, age-squared, marital status, education, household amenities score, material deprivation score, occupational status, years in retirement, health and lifestyle risk factors, as well as frequency of contact with relatives and friends.

Table 15 Beta coefficients for multivariable linear regression of CASP12v3 scores and predictors among Russian men and women

Russia	Men		Women	
Variables	**Regression coefficient (95% CI)**	**β**	**Regression coefficient (95% CI)**	**β**
Constant	17.43		-4.66	
Age	0.24 (1.08 to 1.58)	0.17	**0.98 (-0.03 to 1.99)**	**0.80**
Age squared	-0.003 (-0.01 to 0.01)	-0.24	**-0.01 (-0.02 to 0.001)**	**-0.83**
Marital status (married cohabiting)				
Single	**-1.83 (-3.72 to 0.06)**	**-0.04**	-0.17 (-1.19 to 0.85)	-0.01
Divorced	**-1.15 (-2.30 to 0.002)**	**-0.04**	-0.35 (-0.93 to 0.24)	-0.02
Widowed	**-1.51 (-2.53 to -0.49)**	**-0.06**	0.01 (-0.43 to 0.45)	0.002
P for linear trend	**P<0.001**		0.79	
Education (Primary)				
Vocational	-0.07 (-0.91 to 0.77)	-0.004	**0.71 (0.09 to 1.33)**	**0.06**
Secondary	-0.33 (-1.10 to 0.45)	-0.02	**0.70 (0.11 to 1.29)**	**0.06**
University	0.48 (-0.35 to 1.32)	0.03	**1.15 (0.47 to 1.82)**	**0.08**
P for linear trend	0.37		**0.003**	
Household amenities (Bottom tertile;poorest)				
Middle tertile	0.06 (-0.69 to 0.82)	0.01	0.18 (-0.32 to 0.68)	0.02
Top tertile (Richest)	**1.25 (0.42 to 2.08)**	**0.10**	**1.15 (0.58 to 1.72)**	**0.09**
P for trend	**P=0.001**		**P<0.001**	
Material deprivation score (Low)				
Medium (1-6)	**-2.76 (-3.44 to -2.07)**	**-0.21**	**-2.13 (-2.69 to -1.58)**	**-0.19**
High (7-12)	**-4.25 (-5.10 to -3.41)**	**-0.31**	**-4.01 (-4.63 to -3.38)**	**-0.34**
P for linear trend	**P<0.001**		**P<0.001**	
Years in retirement	0.001 (-0.05 to 0.05)	0.001	**-0.10 (-0.15 to 0.05)**	**-0.09**
Self-rated health status (Very good & Good)				
Average	**-1.11 (2.12 to -0.09)**	**-0.09**	**-2.86 (-4.00 to -1.72)**	**-0.24**
Poor and very poor	**-3.04 (-4.22 to -1.85)**	**-0.22**	**-4.55 (-5.77 to -3.33)**	**-0.38**
P for linear trend	**P<0.001**		**P<0.001**	

Table 15. (Continued)	Men		Women	
	Regression coefficient (95% CI)	β	Regression coefficient (95% CI)	β
Long-term health problems (No)				
Yes	**-0.86 (-1.46 to -0.26)**	**-0.07**	**-0.56 (-0.98 to -0.14)**	**-0.05**
Physical functioning score (Lowest; worst)				
Middle	**1.92 (1.22 to 2.63)**	**0.14**	**1.11 (0.66 to 1.57)**	**0.10**
Highest (Best)	**3.15 (2.34 to 3.97)**	**0.24**	**1.97 (1.36 to 2.58)**	**0.13**
P for linear trend	**P<0.001**		**P<0.001**	
Depressive symptoms (No)				
Yes	**-2.66 (-3.49 to -1.83)**	**-0.15**	**-2.08 (-2.55 to -1.61)**	**-0.17**
Mean BMI	-0.02 (-0.08 to 0.04)	-0.01	0.01 (-0.03 to 0.04)	0.01
Physical activity (no. of hours)	**0.20 (0.16 to 0.24)**	**0.21**	**0.19 (0.15 to 0.23)**	**0.17**
Frequency of contact with family (No family)				
Less than once a month	0.57 (-0.91 to 2.05)	0.04	-0.18 (-1.30 to 0.93)	-0.01
Once a month or more	1.07 (-0.42 to 2.56)	0.07	0.1 (-1.02 to 1.21)	0.01
Once a week or more	1.19 (-0.25 to 2.63)	0.09	-0.03 (-1.10 to 1.04)	-0.002
P for linear trend	0.03		0.73	
Frequency of contact with friends (No friends)				
Less than once a month	**0.92 (0.15 to 1.69)**	**0.07**	**0.87 (0.25 to 1.49)**	**0.08**
Once a month or more	**1.07 (-0.42 to 2.56)**	**0.11**	**1.07 (0.40 to 1.75)**	**0.08**
Once a week or more	**1.20 (-0.25 to 2.63)**	**0.10**	**1.37 (0.69 to 2.04)**	**0.10**
P for linear trend	**P<0.001**		**P<0.001**	
R-squared	0.42		0.33	

Note: Boldface indicates significant result. Multivariable model included age, age-squared, marital status, education, household amenities score, material deprivation score, occupational status, years in retirement, health and lifestyle risk factors, as well as frequency of contact with relatives and friends.

Table 16 Beta coefficients for multivariable linear regression of CASP12v3 scores and predictors among Polish men and women

Poland	Men		Women	
Variables	**Regression coefficient (95% CI)**	**β**	**Regression coefficient (95% CI)**	**β**
Age	0.05 (-0.86 to 0.96)	0.05	-0.11 (-0.91 to 0.70)	-0.10
Age squared	-0.001 (-0.01 to 0.01)	-0.07	0.001 (-0.01 to 0.01)	0.11
Marital status (married cohabiting)				
Single	-0.73 (-1.93 to 0.47)	-0.02	**-0.81 (-1.61 to -0.01)**	**-0.03**
Divorced	-0.86 (-1.79 to 0.08)	-0.03	**-0.97 (-1.65 to -0.28)**	**-0.05**
Widowed	-0.17 (-1.03 to 0.69)	-0.01	**-1.06 (-1.51 to -0.61)**	**-0.08**
P for linear trend	0.38		**P<0.001**	
Education (Primary)				
Vocational	0.59 (-0.05 to 1.23)	0.05	**0.82 (0.20 to 1.43)**	**0.05**
Secondary	0.02 (-0.63 to 0.67)	0.002	**0.80 (0.30 to 1.30)**	**0.07**
University	0.60 (-0.13 to 1.33)	0.04	**0.71 (0.10 to 1.33)**	**0.05**
P for linear trend	0.21		**0.02**	
Household amenities (Bottom tertile; Poorest)				
Middle tertile	**0.65 (0.14 to 1.17)**	**0.06**	0.27 (-0.14 to 0.69)	**0.02**
Top tertile (Richest)	**1.53 (0.93 to 2.12)**	**0.12**	**1.17 (0.63 to 1.72)**	**0.08**
P for linear trend	**P<0.001**		**P<0.001**	
Material deprivation score (Low)				
Medium (1-6)	**-1.79 (-2.23 to -1.34)**	**-0.15**	**-1.51 (-1.91 to -1.11)**	**-0.13**
High (7-12)	**-3.89 (-4.72 to 3.06)**	**-0.18**	**-2.46 (-3.08 to -1.84)**	**-0.15**
P for linear trend	**P<0.001**		**P<0.001**	
Employment status (Employed)				
Not Working	**-1.10 (-1.70 to -0.49)**	**-0.07**	**-1.65 (-2.28 to -1.03)**	**-0.08**
Years in retirement	**-0.04 (-0.07 to -0.01)**	**-0.05**	-0.02 (-0.05 to 0.01)	**-0.03**
Self-rated health status (Very good & Good)				
Average	**-0.75 (-1.24 to -0.25)**	**-0.07**	**-1.20 (-1.70 to 0.70)**	**-0.11**

Table 16. (Continued)	Men		Women	
	Regression coefficient (95% CI)	β	Regression coefficient (95% CI)	β
Poor and very poor	**-1.94 (-2.66 to -1.21)**	**-0.13**	**-2.17 (-2.84 to -1.50)**	**-0.15**
P for linear trend	**P<0.001**		**P<0.001**	
Long-term health problems (No)				
Yes	-0.09 (-0.54 to 0.37)	-0.01	-0.42 (-0.86 to 0.02)	-0.03
Physical functioning score (Lowest; worst)				
Middle	**1.15 (0.62 to 1.69)**	**0.10**	**0.97 (0.55 to 1.40)**	**0.09**
Highest (Best)	**2.38 (1.77 to 3.00)**	**0.20**	**2.29 (1.71 to 2.87)**	**0.16**
P for linear trend	**P<0.001**		**P<0.001**	
Depressive symptoms (No)				
Yes	**-3.86 (-4.38 to -3.33)**	**-0.28**	**-3.99 (-4.39 to -3.58)**	**-0.33**
Mean BMI	0.02 (-0.03 to 0.07)	0.01	**0.06 (0.03 to 0.10)**	**0.06**
Physical activity (no. of hours)	**0.04 (0.02 to 0.07)**	**0.06**	**0.07 (0.04 to 0.09)**	**0.07**
Smoking (Never)				
Past	0.32 (-0.16 to 0.80)	0.03	0.28 (-0.17 to 0.73)	0.02
Current smoker	0.09 (-0.44 to 0.62)	0.01	0.08 (-0.40 to 0.55)	0.01
P for linear trend	0.95		0.08	
Frequency of contact with family (No family)				
Less than once a month	0.03 (-1.06 to 1.13)	0.003	**1.63 (0.72 to 2.55)**	0.12
Once a month or more	0.37 (-0.72 to 1.46)	0.03	**1.83 (0.93 to 2.73)**	0.15
Once a week or more	0.76 (-0.34 to 1.86)	0.06	**1.76 (0.86 to 2.66)**	0.15
P for linear trend	0.02		**0.08**	
Frequency of contact with friends (No friends)				
Less than once a month	0.48 (-0.28 to 1.24)	**0.04**	**0.84 (0.11 to 1.58)**	**0.07**
Once a month or more	**1.01 (0.25 to 1.77)**	0.09	**1.38 (0.66 to 2.10)**	0.12
Once a week or more	**1.32 (0.49 to 2.14)**	**0.09**	**1.84 (1.10 to 2.59)**	**0.14**
P for linear trend	**0.02**		**P<0.001**	
R-squared	0.39		0.43	

Note: Boldface indicates significant result. Multivariable model included age, age-squared marital status, education, household amenities score, material deprivation score, occupational status, years in retirement, health and lifestyle risk factors, as well as frequency of contact with relatives and friends.

5.4 The Association between baseline CASP Scores and all-cause mortality

In this chapter, the baseline characteristics of deceased and surviving subjects were compared. Kaplan-Meier survival curves were presented and the strength of the association between baseline levels of quality of life, captured by the CASP12v3 score, and all-cause mortality, was explored across HAPIEE samples.

5.4.1 Differences between deceased and surviving participants

Of 11,476 participants aged 50 or older, 1,487 participants died between baseline and follow-up. The mean follow-up time ranged from 6.1 years (Russia), 6.9 years (Poland) and 7.9 years (Czech Republic). The crude mortality rates in each population samples were 11.2% (Czech Republic), 15.7% (Russia) and 11.8% in Poland.

Table 17 shows the baseline characteristics and mean CASP scores of subjects who were alive and those who were deceased at the end of the follow-up, with p-values indicating the significance of difference between the two groups. Comparison of CASP scores showed that the scores were significantly higher in surviving participants. Among survivors, CASP-19 scores were 37.9 (95% CI 37.6 to 38.2); 34.0 (95% CI 33.7 to 34.3) and 38.3 (95% CI 38.0 to 38.5) for Czech Republic, Russia, Poland respectively; mean CASP-19 score of deceased participants were 33.6 (95% CI 37.6 to 38.2); 31.4 (95% CI 30.6 to 32.1) and 35.4 (95% CI 34.7 to 36.2) for Czech Republic, Russia, Poland respectively. Those who died were also on average older at baseline than those who survived. Females were more likely to be survivors than men. Survivors were less likely to be smokers, and were more likely to engage in leisure time physical activity. Non-

survivors were less likely to report good self-rated health. Physical functioning score at baseline differed significantly between the deceased and survivors at the end of the follow-up ($P<0.001$).

Table 17 Baseline characteristics of those alive vs those dead at follow-up in HAPIEE

	Czech Republic (N=2,742)			Russia (N=3,804)			Poland (N=4,930)		
	Alive (N=2,435)	**Dead (N=307)**	**p-value**	**Alive (N=3,207)**	**Dead (N=597)**	**p-value**	**Alive (n=4,347)**	**Dead (N=583)**	**p-value**
CASP-19 (mean, 95%CI)	37.9 (37.6 to 38.2)	33.6 (33.7 to 35.5)	P<0.001	34.0 (33.7 to 34.3)	31.4 (30.6 to 32.1)	P<0.001	38.3 (38.0 to 38.5)	35.4 (34.7 to 36.2)	P<0.001
CASP12v1 (mean, 95%CI)	23.4 (23.2 to 23.7)	21.5 (20.9 to 22.2)	P<0.001	20.4 (20.2 to 20.6)	18.9 (18.4 to 19.4)	P<0.001	24.5 (24.4 to 24.7)	23.0 (22.5 to 23.5)	P<0.001
CASP12v2 (mean, 95%CI)	24.3 (24.1 to 24.5)	22.2 (21.5 to 22.8)	P<0.001	21.2 (20.9 to 21.4)	19.5 (19.0 to 20.0)	P<0.001	25.6 (25.4 to 25.7)	23.5 (23.0 to 24.1)	P<0.001
CASP12v3 (mean, 95%CI)	23.4 (23.2 to 23.6)	21.4 (20.8 to 22.1)	P<0.001	21.0 (20.8 to 21.2)	19.3 (18.8 to 19.8)	P<0.001	24.5 (24.3 to 24.7)	22.5 (22.0 to 23.0)	P<0.001
Age (mean, SD)	64.1 (3.87)	65.5 (3.65)		63.2 (4.61)	64.5 (4.44)		61.9 (5.17)	63.3 (5.01)	
Age group (%)			P<0.001			P<0.001			P<0.001
50-54	1.0	0.7		5.0	4.0		10.7	8.6	
55-59	14.4	6.8		20.3	12.9		24.4	17.0	
60-64	41.2	33.6		32.3	26.3		31.2	27.6	
65-69	39.9	52.4		40.2	52.8		31.7	44.8	
70+	3.4	6.5		2.2	4.0		2.0	2.0	
Sex			P<0.001			P<0.001			P<0.001
Men	38.9	62.2		30.8	63.0		43.6	64.7	
Women	61.1	37.8		69.2	37.0		56.4	35.5	
Education			0.23			P<0.001			0.004
Primary	15.1	18.6		16.5	25.3		15.7	19.9	
Vocational	36.8	39.7		25.3	21.8		22.8	26.9	
Secondary	36.6	30.9		36.4	34.7		41.2	36.4	
University	11.1	10.1		21.8	18.2		20.2	16.8	
Missing	0.4	0.7					0.1	0.0	

Table 17. (Continued)	Czech Republic (N=2,742)			Russia (N=3,804)			Poland (N=4,930)		
	Alive (N=2,435)	Dead (N=307)	p-value	Alive (N=3,207)	Dead (N=597)	p-value	Alive (n=4,347)	Dead (N=583)	p-value
Household amenities score (0-12), mean (SD)			0.01		0.02				<0.001
Bottom (poor amenities level)	30.1	22.2		22.0	17.1		38.4	30.5	
Middle tertile	26.3	30.9		32.2	29.7		30.8	28.0	
Top (High amenities level)	43.6	46.9		45.8	53.2		30.8	41.5	
Occupational status			0.02						0.06
working pensioner	11.3	6.5					11.2	8.1	
Non-working pensioner	88.3	92.5					88.7	91.9	
Missing	0.4	1.0					0.1	0	
Years in retirement - Mean (SD)	7.1 (0.1)	7.8 (0.1)	0.99	8.7 (0.1)	9.1 (0.2)	0.94	8.9 (0.1)	10.8 (0.3)	1.00
Marital status			0.92						0.02
Married or cohabiting	74.7	73.9		64.8	68.3	0.07	73.3	70.1	
Single	1.6	2.0		3.3	1.5		4.1	6.4	
Divorced	9.2	9.1		10.2	9.6		6.7	8.6	
Widowed	14.4	14.7		21.7	20.6		15.9	14.9	
Missing	0.1	0.3							
Health status			P<0.001			P<0.001			<0.001
Very good and good	35.4	18.6		5.1	4.2		24.1	14.2	

Table 17. (Continued)	Czech Republic (N=2,742)			Russia (N=3,804)			Poland (N=4,930)		
	Alive (N=2,435)	**Dead (N=307)**	**p-value**	**Alive (N=3,207)**	**Dead (N=597)**	**p-value**	**Alive (n=4,347)**	**Dead (N=583)**	**p-value**
Average	55.2	59.6		64.1	46.9		57.5	53.3	
Poor and very poor	9	21.2		30.8	48.9		18.3	32.4	
Missing	0.4	0.6					0.1	0.0	
Long term health problems			0.03			P<0.001			0.05
No	32.4	25.1		51.5	37.4		31.8	27.4	
Yes	66.6	73.6		48.5	62.6		67.7	71.7	
Missing	1.0	1.3					0.5	0.9	
Physical functioning score Tertile			P<0.001			P<0.001			<0.001
Lowest (worst)	36.3	52.8		36.0	51.8		34.3	48.5	
Middle	30.4	25.7		39.0	29.5		38.2	34.5	
Highest (Best)	32.4	19.9		25.0	18.7		26.8	16.1	
Missing	0.9	1.6					0.7	0.9	
Depressive symptoms (CES-D 20)			0.07			0.09			0.003
No	78.7	73.0		49.5	44.7		71.1	64.3	
Yes	16.4	20.9		23.5	24.8		27.5	33.8	
Missing	4.9	6.1		27.0	30.5		1.4	1.9	
Smoking			P<0.001			P<0.001			<0.001
Never	51.0	28.3		72.8	41.9		45.2	26.8	
Past	30.1	39.7		10.8	18.9		30.0	31.2	
Currently	18.4	30.9		16.4	39.2		24.6	41.2	
Missing	0.5	1.0					0.2	0.8	
Physical activity Hours per week – mean (SD)	5.2 (0.1)	4.5 (0.4)	0.03	2.3 (5.8)	1.8 (5.2)	0.03	6.0 (6.6)	5.4 (7.0)	0.01
BMI (mean, SD)	28.9 (0.1)	29.6 (0.3)	0.09	29.4 (5.6)	28.4 (6.1)	P<0.001	28.8 (4.6)	28.6 (5.1)	0.19

Table 17. (Continued)	Czech Republic (N=2,742)			Russia (N=3,804)			Poland (N=4,930)		
	Alive (N=2,435)	Dead (N=307)	p-value	Alive (N=3,207)	Dead (N=597)	p-value	Alive (n=4,347)	Dead (N=583)	p-value
Social contact & relationships									
Frequency of contact with relatives			0.08			0.004			<0.001
No relatives	0.9	1.6		3.2	4.0		4.4	6.0	
Less than once a month	8.5	11.4		23.4	29.8		25.5	35.0	
Once a month or more	25.1	28.7		21.4	19.9		35.8	34.1	
Once a week or more	64.7	58.0		52.0	46.3		34.0	24.7	
Missing	0.8	0.3					0.3	0.2	
Frequency of contact with friends			0.001			0.04			<0.001
No relatives	2.4	5.9		13.7	17.6		7.9	12.0	
Less than once a month	20.5	22.5		38.6	39.0		30.0	35.0	
Once a month or more	42.3	45.0		23.3	22.3		38.9	32.3	
Once a week or more	34.3	25.7		24.4	21.1		22.6	19.9	
Missing	0.5	0.9					0.6	0.8	

5.4.2 Age-standardized mortality rates

The mortality levels in each CASP12v3 score tertile groups were measured by means of directly standardized mortality rates using the European standard population as a reference population (Ahmad et al., 2001). This standardization procedure allows direct comparison of mortality rates between populations with different age distributions (Naing, 2000)

Table 18 shows the country-specific and gender-specific age-standardised mortality rates (ASMRs) per 1000 person-years for the whole sample and in each QOL groups. Large differences in ASMRs were observed across cohorts and between men and women. In both genders, highest mortality was observed in Russia. Among men, ASMRs were 19.57 per 1000 person-years (95% CI 16.79 to 22.35), 49.68 (95% CI 44.66 to 54.70), and 23.11 per 1000 person-years (95% CI 20.78 to 25.44) in Czech Republic, Russia and Poland respectively; among women, the corresponding ASMRs were 9.69 (95% CI 7.93 to 11.45), 14.22 (95%CI 12.35 to 16.90) and 10.17 per 1000 person-years (95% CI 8.78 to 11.56) in Russia.

Overall, the absolute mortality differences between the bottom and top tertile of CASP12v3 were generally smaller in women than in men. The largest mortality difference was found in Russian men; the rates (per1000 person-years) from the lowest to highest tertile were 67.94, 51.97, and 33.83, respectively. Among women, the corresponding rates were 19.49, 18.41 and 11.38. There was a significant increasing trend of observed death rates across CASP12v3 tertiles (P for trend<0.001).

Table 18 Country-specific and gender-specific numbers of deaths and age-standardised mortality rates (ASMRs) per 1000 person-years by CASP12v3 score tertile (HAPIEE mortality follow-up data)

	Men						Women					
	Czech		Russia		Poland		Czech		Russia		Poland	
	Deaths	ASMR (95% CI)	Deaths	ASMR (95% CI)	Deaths	ASMR (95% CI)	Deaths	ASMR (95% CI)	Deaths	ASMR (95% CI)	Deaths	ASMR (95% CI)
Whole sample	191	19.57 (16.79 to 22.35)	376	49.68 (44.66 to 54.70)	377	23.11 (20.78 to 25.44)	116	9.69 (7.93 to 11.45)	221	14.22 (12.35 to 16.90)	206	10.17 (8.78 to 11.56)
CASP12v3 score (Tertile)												
High QOL	35	13.58 (9.09 to 18.08)	101	33.83 (27.23 to 40.43)	92	17.33 (13.79 to 20.87)	12	5.14 (2.23 to 8.05)	42	11.38 (7.94 to 14.82)	39	6.59 (4.52 to 8.66)
Intermediate QOL	68	17.73 (13.52 to 21.94)	115	51.97 (42.27 to 61.46)	120	23.24 (19.08 to 27.40)	41	11.27 (7.82 to 14.72)	65	18.41 (13.93 to 22.89)	57	8.13 (6.02 to 10.24)
Low QOL	88	44.95 (35.55 to 54.34)	160	67.94 (57.41 to 78.47)	165	28.85 (24.45 to 33.25)	63	11.68 (8.80 to 14.56)	114	19.49 (15.91 to 23.07)	110	16.16 (13.14 to 19.18)
p for trend		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001

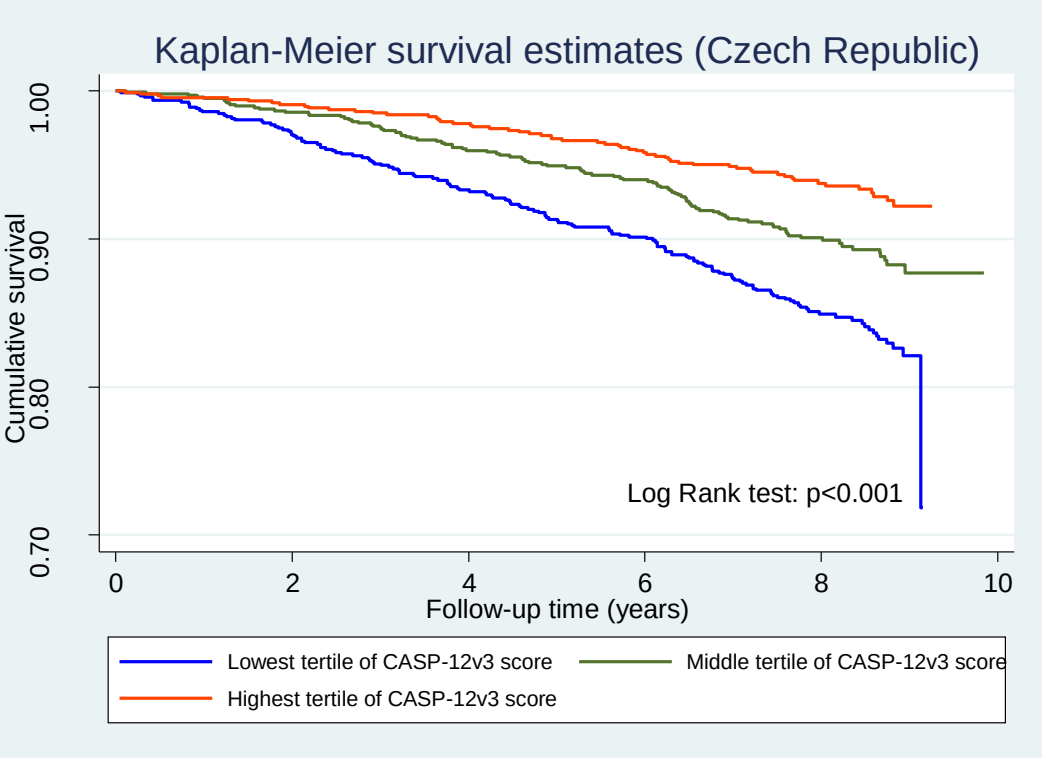
Note: Reference population for age-standardization was taken from the European standard population.

5.4.3 Kaplan-Meier survival curves

For each country, the differences in survival in relation to quality of life were investigated by plotting Kaplan–Meier survival curves for tertile groups of CASP12v3 score. The differences in survival across tertiles of CASP-19 score were then tested statistically using the log-rank test of equality.

Figures 21, 22 and 23 show the Kaplan-Meier curves for all-cause mortality over time in the three countries. The Kaplan–Meier survival plots show that, in each country, participants in the highest tertile of CASP12v3 score have significantly better survival than those patients in the middle and low tertiles. In the Czech Republic, the cumulative 5-year survival rates in the low, middle, and high CASP12v3 tertiles were 91.1%, 94.8%, and 96.0% respectively ($p < 0.001$, Figure 21); for Russian participants in the lowest, middle, and highest tertiles of CASP12v3 score, the survival rates were 80.1%, 87.8%, and 89.1% (Figure 22). In Poland, the estimated survival rate for the highest tertile was 92.9%, compared with 91.6 and 87.5% for the middle and lowest tertiles, respectively ; log rank chi-squared, $P<0.001$ (Figure 23).

Figure 21 Kaplan-Meier survival estimates for tertile of CASP12v3 score (Czech Republic)



Kaplan–Meier curves show the cumulative survival according to tertiles of CASP12v3 score for all-cause mortality.

Figure 22 Kaplan-Meier survival estimates for tertile of CASP12v3 score (Russia)

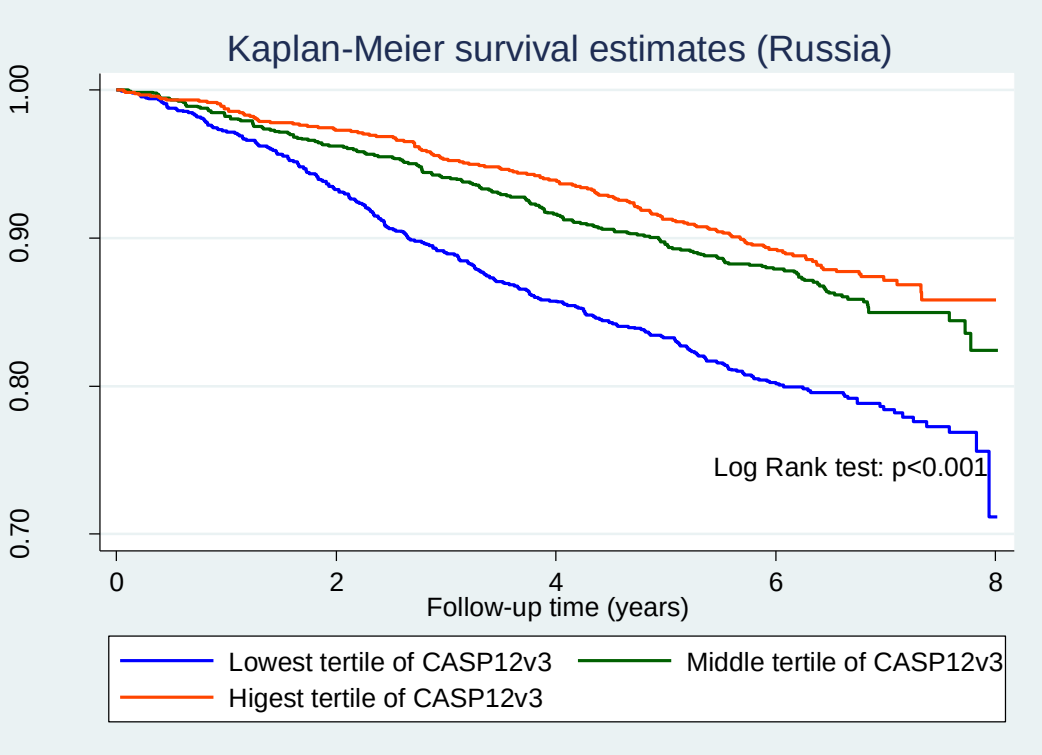
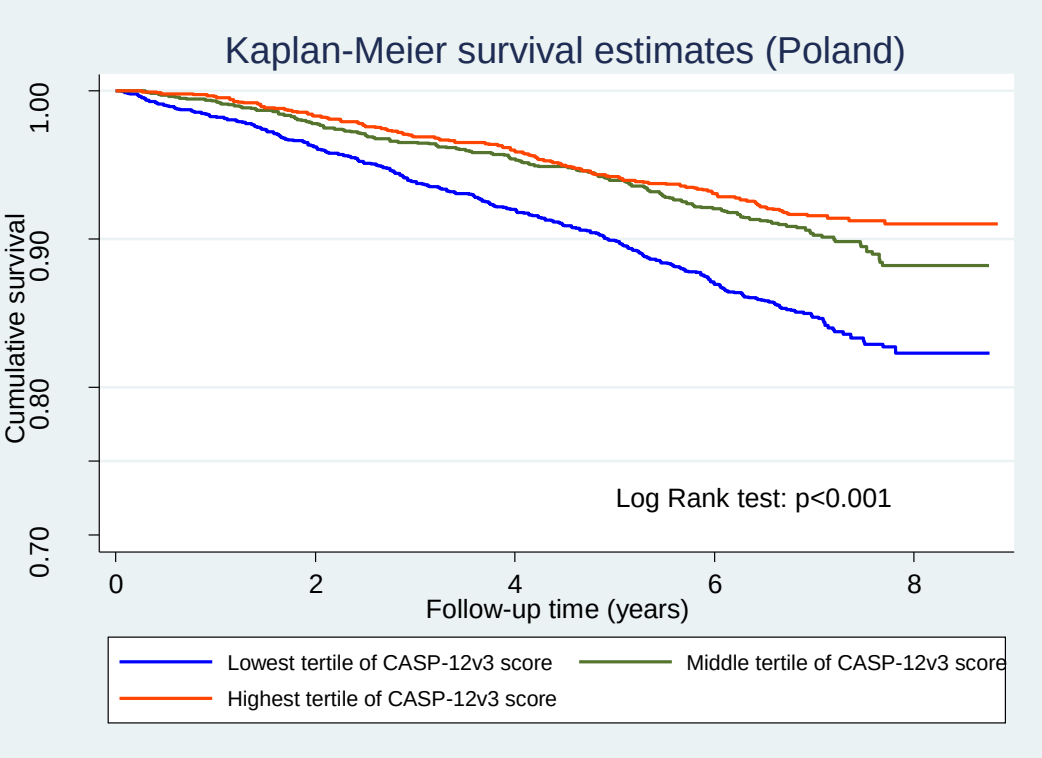


Figure 23 Kaplan-Meier survival estimates for tertile of CASP12v3 score (Poland)



5.4.4 Cox proportional hazard models

The association of baseline CASP score with all-cause mortality was evaluated using Cox proportional hazard models, after controlling for age, sex, socio-demographic, health, lifestyle variables and social relationship variables. The unadjusted and multivariable hazard ratios and 95% confidence intervals of death were assessed for continuous CASP-19 scores and for each of the 12-item CASP scores: CASP12v1, CASP12v2 CASP12v3 scores (See appendices 1, 2, and 3 pages 212 to 214). To further understand the specific aspects of CASP most strongly associated with survival, additional analyses were conducted using the domain scores (Control, Autonomy, Self-realisation, Pleasure) in place of the broader CASP-19 summary indices, separately for each cohort.

Appendices 1, 2, and 3 (pages 212 to 214) demonstrate the hazard ratios (95%

CIs) for all-cause mortality using four different continuous score of CASP for each cohort. Results of domain-specific analysis are also illustrated. In all analyses, the crude associations of the CASP scores and of the four CASP domains with all-cause mortality were all significant; a one unit increase in CASP-19 total score predicted 5.0% decreased HR of death for Czech Republic (95% CI 0.94 to 0.97) and 3.0% decreased HR of death for Russia (95% CI 0.96 to 0.98) and Poland (95% CI 0.96 to 0.98). However, in the multivariable fully adjusted models, the mortality risk was not statistically significant across all samples. Similar results were obtained using the other three CASP-12 scores.

In the domain-specific analysis, the individual CASP domains showed differential effects on mortality. High scores on each of the domains were protective against mortality. The crude associations indicated that a one unit change in the control domain score reduced the probability of death by 9%,5%, and 11% for Czech Republic, Russia, and Poland respectively) while the same for the autonomy domain reduced it by 10%, 8%, 5%. During the follow-up, one unit increase in the pleasure domain score was related to 13%, 7%, and 7% lower HR of death. However, in the multivariable model adjusted with all the covariates, only pleasure domain remained statistically significant in the Czech sample. For Poland, only the control domain was found to be significant. In Russia, autonomy was significantly associated with a lower risk of all-cause mortality (HR, 0.95 ; 95% CI, 0.92 to 0.99)(see Appendix 2 page 213).

Subsequently, the crude mortality rates per 1000 person-years were calculated for the whole sample according to country-specific tertile of CASP12v3 score. Also, Cox proportional hazard ratios (HR) and their 95% CI were estimated in

order to express the strength of association of being in each of the lower two CASP tertiles, compared to the highest tertile adjusting for relevant covariates. CASP scores were divided into country-specific tertiles; the highest tertile was used as reference (Table 19). As there were no significant interactions between CASP12v3 and sex in the association with all-cause mortality in each cohort (p-values for interaction ranging between 0.34 and 0.83), the analyses was not stratified by sex. The data also did not reveal statistically significant interaction between the effects of CASP and age group on mortality outcome.

Table 19 column 3) shows crude incidence rates of all-cause mortality and the HR (95% CIs) by tertiles of CASP12v3 score for each country of HAPIEE. Crude incidence rates of all-cause mortality increased across tertiles of CASP12v3. In the Czech Republic, the corresponding mortality rates in each tertile of CASP12v3 were 8.06, 13.41, and 19.74 per 1000 person-years, respectively from the highest tertile to lowest tertile. In Russia, the death rates per 1000 person years were 35.63 in those with poor quality of life, 22.42 in those with intermediate quality of life, and 19.29 in participants with highest quality of life. For Polish sample, death rates per 1000 person years were 12.44, 15.32 and 23.46 respectively from the highest to lowest QOL tertile group.

In Cox proportional hazards models adjusted for gender and age (Table 19, Model 1), there was a distinct association between low CASP12v3 scores and all-cause mortality, showing that participants with CASP12v3 scores in the lowest tertile have an increased mortality risk compared to those in the highest quartile. For example, in Czech Republic, HRs were 1.73 (95% CI 1.23 to 2.44) and 2.60 (95% CI 1.87 to 3.60) for those with CASP scores in the intermediate and lowest

tertile (poor QOL), respectively, compared with individuals with high QOL. In Poland, the corresponding HRs were 1.26 (95% CI 1.01 to 1.58) and 1.98 (95% CI 1.61 to 2.44). Russians with poor CASP12v3 had a twofold higher mortality risk (95% CI 1.63 to 2.45) compared to subjects in the reference group. P for trend statistics confirmed that the HRs elevates linearly across CASP12v3 quartiles in all applied models ($p<0.05$), with the highest tertile of quality of life as the reference.

In all three cohorts, the association between CASP12v3 score and mortality remained statistically significant after additionally adjusting for marital status and three socioeconomic position variables (education, household amenities score, years in retirement, and material deprivation score). Among Czechs, the corresponding adjusted HR for mortality for a low vs. high QOL was 2.19 (95% CI 1.54 to 3.10) (Table 19, Model 2). In the Russian and Polish samples, the effect of CASP score on mortality was slightly reduced by adjustments for SEP variables and marital status (HR, 1.87; 95% CI 1.51 to 2.32; HR 1.52, 95% CI 1.21 to 1.92, respectively). The next model then additionally adjusted for behavioural risk factors (obesity and physical activity), which led to further attenuation of the HRs but the association was still significant. The inclusion of potentially confounding depressive symptoms attenuated the association; nevertheless, participants with poor QOL (quartile 3) still had significantly higher mortality risk than the reference group across all cohorts. HRs were 1.45 (95% CI 1.02 to 2.08) and 1.75 (95% CI 1.21 to 2.51) for those with CASP scores in the intermediate and lowest tertile (poor QOL), respectively, compared with individuals with high QOL in the Czech Republic. In Russia, participants with poor CASP12v3 score had 1.70 higher mortality risk (95% CI 1.35 to 2.13) compared to subjects in the reference group (P for trend $P<0.001$) (Table 19 Model 4).

Similarly, HRs were 1.12 (95% CI 1.08 to 1.46) and 1.43 (95% CI 1.08 to 1.89) for Polish older adults with CASP scores in the intermediate and lowest tertile (poor QOL), respectively, compared with individuals with high QOL (P for trend=0.03).

However, in all three cohorts the HR for the poor QOL group was reduced further and was no longer significant when also adjusted for physical health variables (Table 19, Model 5). The final model (Table 19, Model 6), which also adjusted for social relationship variables, showed a non-significant 1.31-fold increased hazard (95% CI 0.89 to 1.93; p = 0.36) for the poor QOL group compared to high QOL group. The corresponding HRs were, 1.20 (95% CI 0.94 to 1.52) and 1.15 (95% CI 0.86 to 1.53), in Russia and Poland, respectively. The Proportional hazard assumptions for Cox regression models, tested using Schoenfeld residuals, were found not to be violated.

Table 19 Hazard ratios (95% CIs) for all-cause mortality according to tertiles of CASP12v3 in three countries of HAPIEE

	Cases	Person-years (per 1000 person-years)	Model 1 (Age, age-squared & sex)	Model 2 (M1+marital status+ SEP variables)	Model 3 (M2+obesity +physical activity)	Model 4 (M3 + Depressive symptoms)	Model 5 (M4+ Physical health)	Model 6 (Fully adjusted model)
Czech Republic	(n)							
High QOL	47	8.06	1.00	1.00	1.00	1.00	1.00	1.00
Intermediate QOL	109	13.41	**1.73 (1.23 to 2.44)**	**1.59 (1.12 to 2.26)**	**1.47 (1.03 to 2.09)**	**1.45 (1.02 to 2.08)**	1.27 (0.88 to 1.83)	1.27 (0.88 to 1.83)
Low OOL	151	19.74	**2.60 (1.87 to 3.60)**	**2.19 (1.54 to 3.10)**	**1.81 (1.26 to 2.59)**	**1.75 (1.21 to 2.51)**	1.36 (0.93 to 1.99)	1.31 (0.89 to 1.93)
p-value for linear trend			**P<0.001**	**P<0.001**	**P=0.005**	**P=0.01**	P=0.29	P=0.36
Russia								
High QOL	143	19.29	1.00	1.00	1.00	1.00	1.00	1.00
Intermediate QOL	180	22.42	1.22 (0.98 to 1.52)	1.19 (0.95 to 1.49)	1.17 (0.94 to 1.47)	1.15 (0.92 to 1.44)	1.00 (0.80 to 1.26)	1.00 (0.80 to 1.26)
Low OOL	274	35.63	**2.00 (1.63 to 2.45)**	**1.87 (1.51 to 2.32)**	**1.82 (1.46 to 2.26)**	**1.70 (1.35 to 2.13)**	1.21 (0.96 to 1.54)	1.20 (0.94 to 1.52)
p-value for linear trend			**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	P=0.12	P=0.16
Poland								
High OOL	31	12.44	1.00	1.00	1.00	1.00	1.00	1.00
Intermediate QOL	177	15.32	**1.26 (1.01 to 1.58)**	1.12 (0.89 to 1.41)	1.14 (0.88 to 1.48)	1,12 (1.08 to 1.46)	0.98 (0.75 to 1.29)	0.97 (0.74 to 1.28)
Low QOL	275	23.46	**1.98 (1.61 to 2.44)**	**1.52 (1.21 to 1.92)**	**1.51 (1.16 to 1.97)**	**1.43 (1.08 to 1.89)**	1.19 (0.89 to 1.58)	1.15 (0.86 to 1.53)
p-value for linear trend			**P<0.001**	**P=0.001**	**P=0.01**	**P=0.03**	P=0.28	P=0.40

Note: Significant results are highlighted in bold. Fully adjusted HRs and 95% CIs adjusted for age, age-squared, sex, marital status, education, household amenities score, material deprivation score, occupational status, years in retirement, self-rated health, long-term health problems, physical functioning, depressive symptoms, obesity, physical activity, and frequency of contact with friends, and relatives.

In summary, findings of this project shown in **Chapter 5.4** partially support the first research hypothesis (see **Section 3.3**) of CASP as a significant predictor of all-cause mortality. The link between CASP score and all-cause mortality appeared to be influenced, to a varying extent, by socio-demographic factors, behavioural risk factors, depressive symptoms, physical health and social relationship variables, as demonstrated by the changes in HR values after controlling for these additional risk determinants. However, the impact of the physical health variables was relatively strong and resulted in the loss of statistical significance for the main association of interest. The association was no longer significant after adjusting for all variables.

5.5 Possible mechanisms linking CASP and subsequent mortality: estimation of direct and indirect effects of CASP12v3 on all-cause mortality through mediators.

Despite the growing body of evidence on the association between quality of life at old and survival, the possible mechanisms through which CASP score exerts its influence are not well understood. This project aimed to expand upon prior work by including an evaluation of the different potential mediating pathways through which CASP12v3 score may contribute to prediction of survival.

Using structural equation modeling and controlling for relevant covariates such as age, sex, socioeconomic position, marital status and depressive symptoms, the direct effects of CASP12v3 score on mortality risk were estimated for each cohort. The mediation analyses also tested the hypothesis that CASP12v3 score

has an indirect effect on mortality via indicators of physical health, social network variables and health behaviour variables.

5.5.1 Spearman's correlation among study variable

Tables 20,21 and 22 display the Spearman's correlation among the study variables in each sample. Overall, similar correlations were found across countries. There were significant correlations between the majority of variables and all the observed correlations were in the expected direction. For instance, a strong negative relationship was found between CASP12v3 score and physical health variables, where higher quality of life scores were reported by individuals with better self-rated health and physical functioning score ($p<0.05$). In the Czech Republic and Poland, depressive symptom was significantly associated with CASP12v3 scores ($r = -0.31$, $r= -0.45$, $P < 0.05$ respectively), where participants with depressive symptoms reported worse CASP12v3 scores compared to those without depressive symptoms. Greater age and female gender were associated with poorer quality of life. There was only a moderate positive correlation between education level and CASP12v3 score, while high household amenities scores were strongly correlated with higher quality of life. Similarly, there was a strong negative correlation between material deprivation score and CASP12v3 score. Moreover, the correlation coefficients between the three SEP variables varied between -0.12 to 0.29 (Czech Republic); –0.34 to 0.25 (Russia); between -0.25 to 0.30 (Poland). Household amenities score was positively correlated with education status, whereas there were significant negative correlations ($P<0.01$) between material deprivation and education level, and household amenities score and deprivation. The correlations between the physical health variables

were moderately high. There was a positive correlation between self-rated health and physical functioning score, while presence of long-term health problems was found to be negatively correlated with self-rated health and with physical functioning score. The correlation coefficients ranged between -0.42 to 0.54 (Czech Republic), -0.50 to -0.39 (Russia), -0.39 to 0.49 (Poland). These results indicated that there is potential for multi-collinearity among the three physical health variables as well as among SEP variables ($r \geq 0.3$).

In each case, principal component analysis (PCA) with varimax rotation was used to examine the factor structure among the variables. Only the first principal component, that had eigenvalue greater than 1, was extracted. This one-factor solution explained between 49.3% and 62.6% of the variance among the physical health variables in the three HAPIEE samples. Likewise, PCA of the socioeconomic position variables yielded a one-factor solution with eigenvalue greater than 1. This factor explained between 46.0% to 50.0% of the variances among the three SEP variables. The respective factor scores (as continuous variable) were subsequently included in mediation analyses.

Table 20 Spearman's correlations among variables of interest in the Czech data

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1) Age	1															
2) Sex	**-0.21**	1														
3) Marital status	0.03	**0.23**	1													
4) Deprivation	**-0.08**	**0.10**	**0.11**	1												
5) Education	0.04	**-0.12**	**-0.05**	**-0.12**	1											
6) Household amenities	**-0.07**	**-0.13**	**-0.36**	**-0.24**	**0.29**	1										
7) Frequency of contact with friends	0.01	**0.11**	**0.17**	-0.03	-0.03	-0.01	1									
8) Frequency of contact with relatives	-0.01	**0.14**	**0.05**	0.01	-0.02	0.03	0.23	1								
9)) CESD-20	0.01	**0.13**	**0.10**	**0.17**	**-0.10**	**-0.14**	-0.01	**-0.05**	1							
10) Long-term health problems	**0.07**	0.03	-0.01	**0.07**	-0.04	-0.02	-0.01	0.01	**0.13**	1						
11) Physical functioning	**-0.08**	**-0.13**	**-0.07**	**-0.15**	**0.20**	**0.16**	0.02	0.02	**-0.20**	**-0.38**	1					
12) self-rated health	**-0.07**	0.01	**-0.04**	**-0.16**	**0.16**	**0.14**	**0.07**	0.04	**-0.20**	**-0.42**	**0.54**	1				
13) BMI	0.02	0.03	**0.06**	**0.04**	**-0.20**	**-0.05**	-0.01	-0.01	0.04	**0.11**	**-0.25**	**-0.14**	1			
14) Physical activity	-0.03	-0.01	0.02	**-0.05**	**0.13**	0.04	**0.05**	0.03	**-0.07**	**-0.05**	**0.24**	**0.15**	**-0.14**	1		
15) CASP12v3	**-0.04**	**-0.05**	**-0.09**	**-0.32**	**0.12**	**0.19**	**0.14**	**0.10**	**-0.31**	**-0.25**	**0.38**	**0.39**	**-0.08**	**0.12**	1	
16) All-cause mortality	**0.08**	**-0.14**	-0.01	**0.04**	-0.04	**-0.05**	**-0.05**	-0.02	**0.04**	0.05	**-0.10**	**-0.12**	**0.06**	-0.03	**-0.10**	1

Significant correlations are highlighted in bold
Spearman's correlations between 3 SEP variables and 3 physical health variables indicate potential for multi-collinearity

Table 21 Spearman's correlations among variables of interest in the Russian data

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1) Age	1															
2) Sex	**-0.11**	1														
3) Marital status	**0.08**	**0.31**	1													
4) Deprivation	0.04	**0.08**	**0.12**	1												
5) Education	**-0.12**	-0.01	**-0.05**	**-0.17**	1											
6) Household amenities	**-0.17**	**-0.07**	**-0.24**	**-0.34**	**0.25**	1										
7) Frequency of contact with friends	-0.01	**0.05**	0.03	**-0.19**	**0.06**	**0.08**	1									
8) Frequency of contact with relatives	-0.01	**0.10**	0.02	**-0.16**	**0.08**	**0.07**	**0.16**	1								
9) CESD-20	0.03	**0.05**	**0.10**	**0.38**	**-0.20**	**-0.20**	**-0.27**	**-0.24**	1							
10) Long-term health problems	0.01	**0.04**	0.01	0.02	0.02	**-0.04**	**0.06**	**0.09**	**-0.07**	1						
11) Physical functioning	**-0.08**	**-0.17**	**-0.08**	**-0.21**	**0.09**	**0.17**	**0.06**	-0.01	**-0.13**	**-0.40**	1					
12) self-rated health	**-0.06**	**-0.07**	**-0.06**	**-0.16**	**0.09**	**0.14**	**0.04**	0.01	**-0.12**	**-0.39**	**0.50**	1				
13) BMI	-0.03	**0.35**	**0.08**	-0.01	-0.02	0.01	**0.05**	**0.07**	-0.02	**0.10**	**-0.18**	**0.08**	1			
14) Physical activity	**-0.05**	-0.01	-0.01	**-0.08**	**0.16**	**0.13**	**0.12**	0.02	**-0.22**	0.02	**0.06**	**0.06**	-0.03	1		
15) CASP12v3	**-0.13**	**-0.07**	**-0.10**	**-0.36**	**0.14**	**0.32**	**0.13**	**0.04**	**-0.16**	**-0.23**	**0.41**	**0.37**	**-0.05**	**0.23**	1	
16) All-cause mortality	**0.11**	**-0.24**	-0.02	0.03	**-0.06**	**-0.10**	**-0.04**	**-0.05**	**0.04**	**0.10**	**-0.11**	**-0.13**	**-0.07**	**-0.06**	**-0.10**	1

Note: Significant correlations are highlighted in bold
Spearman's correlations between 3 SEP variables and 3 physical health variables indicate potential for multi-collinearity

Table 22 Spearman's correlations among variables of interest in the Polish data

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1) Age	1															
2) Sex	**-0.08**	1														
3) Marital status	**0.09**	**0.27**	1													
4) Deprivation	**-0.15**	**0.13**	**0.15**	1												
5) Education	**0.05**	**0.04**	0.01	**-0.13**	1											
6) Household amenities	**-0.14**	**-0.14**	**-0.28**	**-0.25**	**0.30**	1										
7) Frequency of contact with friends	0.02	**0.09**	**0.14**	-0.02	**0.07**	0.03	1									
8) Frequency of contact with relatives	-0.02	**0.07**	0.02	**-0.08**	0.01	**0.07**	**0.19**	1								
9) CESD-20	**-0.07**	**0.13**	**0.12**	**0.24**	**-0.06**	**-0.18**	**-0.07**	**-0.08**	1							
10) Long-term health problems	-0.03	**0.08**	0.02	**0.13**	0.03	-0.02	0.01	**-0.03**	**0.14**	1						
11) Physical functioning	-0.02	**-0.17**	**-0.05**	**-0.25**	**0.10**	**0.16**	**0.04**	**0.09**	**-0.24**	**-0.39**	1					
12) self-rated health	**0.05**	**-0.07**	**-0.03**	**-0.22**	**0.17**	**0.18**	**0.06**	**0.07**	**-0.24**	**-0.36**	**0.49**	1				
13) BMI	**0.03**	**0.07**	0.02	0.01	**-0.09**	0.02	0.01	0.02	-0.02	**0.04**	**-0.10**	**-0.06**	1			
14) Physical activity	0.02	**-0.04**	0.02	**-0.12**	**0.03**	**0.07**	**0.10**	**0.11**	**-0.10**	**-0.10**	**0.25**	**0.14**	**-0.06**	1		
15) CASP12v3	0.01	**-0.06**	**-0.13**	**-0.35**	**0.14**	**0.31**	**0.11**	**0.13**	**-0.45**	**-0.20**	**0.39**	**0.35**	0.01	**0.17**	1	
16) All-cause mortality	**0.08**	**-0.14**	0.01	**0.04**	-0.03	**-0.05**	**-0.04**	**-0.06**	**0.03**	**0.03**	**-0.10**	**-0.10**	-0.02	-0.03	**-0.08**	1

Note: Significant correlations are highlighted in bold;
Spearman's correlations between 3 SEP variables and 3 physical health variables indicate potential for multi-collinearity.

5.5.2 Direct and indirect effects of CASP12v3 scores on all-cause mortality

To explore hypothesized direct and meditational effects, a series of simple mediation analyses was conducted which evaluated significant direct effect between two variables, baseline CASP12v3 score and all-cause mortality.

Table 23 displays the standardized and unstandardized regression coefficients and corresponding hazard ratios (HR) for the direct relationship between CASP12v3 score and mortality. This model did not include any mediating variables. In each cohort, the direct effects of baseline CASP12v3 score on all-cause mortality, were statistically significant and in the predicted direction, after controlling for the effects of age, sex, marital status, SEP and depressive symptoms. The negative path coefficient for the CASP12v3 –> All-cause mortality path indicated that as quality of life scores increases, the risk of mortality decreases. For example among Czechs, per one unit increase in CASP12v3 score was associated with a 6% decreased hazard of dying over the follow-up period. In the Russian and Polish data, there was 4% decrease in the risk of death for every one unit increase in CASP12v3 score ($P<0.001$). In terms of standard deviation units, a one standard deviation increase in CASP12v3 score is associated with a decrease in the risk for death by 34%, 30%, and 32% in Czech Republic, Russia and Poland, respectively.

Table 23 Results showing unstandardized/ standardized path coefficients, and corresponding hazard ratios, for the direct relationship between CASP12v3 and all-cause mortality

Country	Unstandardized regression coefficient (95% CI)	Hazard ratio	standardized regression coefficient (95% CI)	Hazard ratio	P-value
Czech Republic	-0.06 (-0.08 to -0.04)	0.94	-0.42 (-0.56 to -0.29)	0.66	<0.001
Russia	-0.04 (-0.06 to -0.03)	0.96	-0.35 (-0.45 to -0.25)	0.70	<0.001
Poland	-0.04 (-0.06 to -0.03)	0.96	-0.39 (-0.49 to -0.28)	0.68	<0.001

This model controlled for age, sex, marital status, SEP, and symptoms of depression.

Single Mediation Analysis

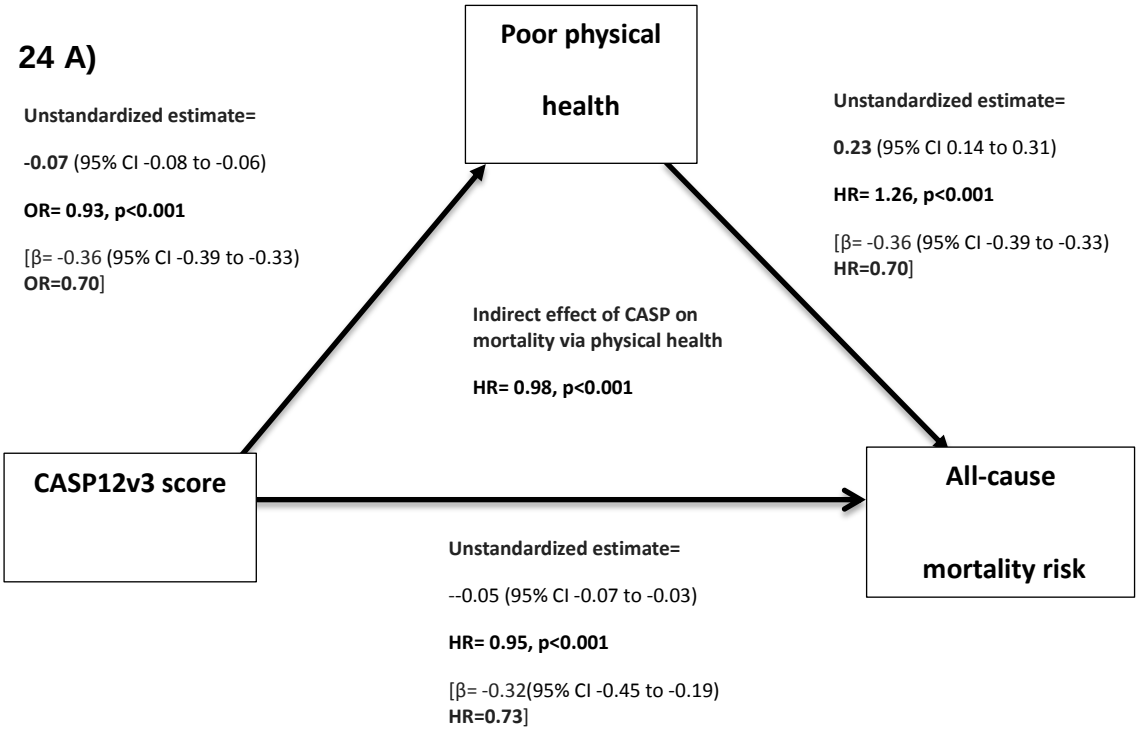
Mediation analyse confirmed that quality of life influenced mortality by both direct and indirect pathways. Of the mediators investigated by SEM, only physical health and frequency of contact with family represented significant indirect pathways from CASP12v3 score to mortality. Figure 24, 25, and 26 show the results of simple mediation analysis for each of the five postulated mediating variable (physical health, obesity , physical activity, frequency of contact with family, frequency of contact with friends), in the three cohorts. Each model adjusted for the confounding effects of age, sex, marital status, SEP and depressive symptoms. However, these were not shown in the figures below so as to more clearly convey the primary findings.

As shown in figure 24A, among Czech older adults CASP12v3 score exerted its impact on all-cause mortality indirectly through physical health. Baseline CASP12v3 score was significant in predicting mortality (Direct effect: HR= 0.95, p<0.001). Moreover, poor physical health also had a significant direct effect on the hazard of dying (HR= 1.26, p<0.001). The estimated unstandardized coefficient indicated that, for every unit increase in CASP12v3 score, the hazard of dying decreases by 2%, through physical health (Indirect effect : HR=0.98, p<0.001). The direct effect of CASP12v3 score on mortality remained significant

after including physical health in the mediation model. Hence, the effect of physical health on CASP and all-cause mortality was a partial mediation effect. The overall total effect of CASP12v3 on mortality risk was significant (HR=0.94, P<0.001).

Figure 24 The estimation of the direct and indirect effect of CASP12v3 score on mortality in the Czech Republic

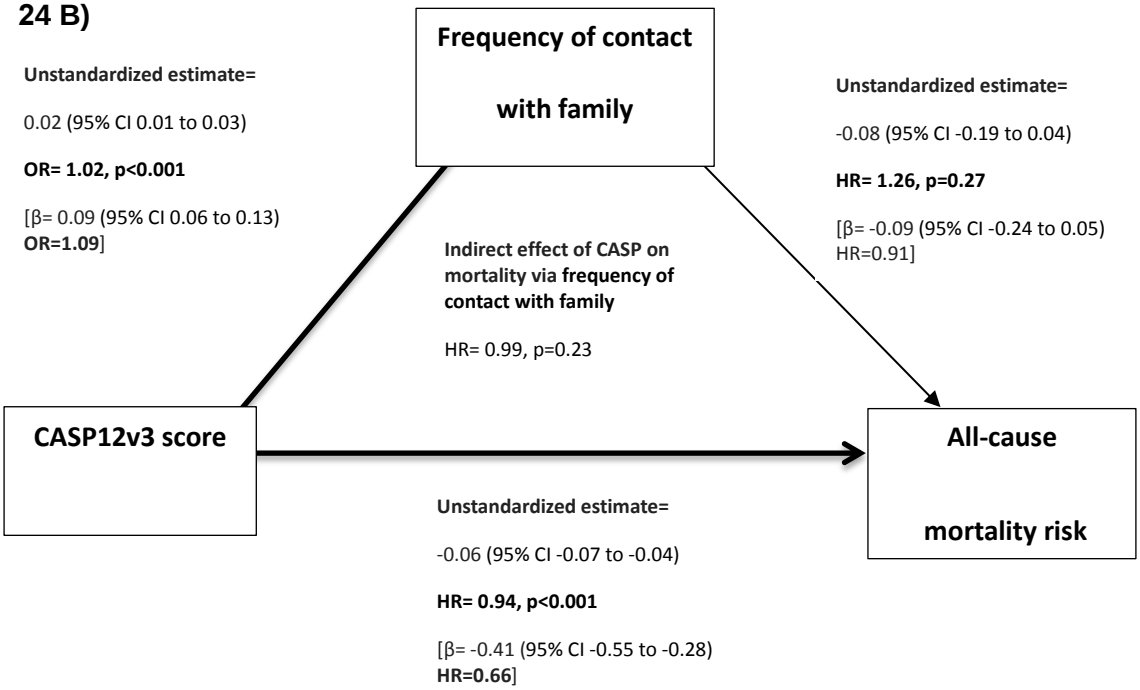
Bolded arrows indicate significant direct effects



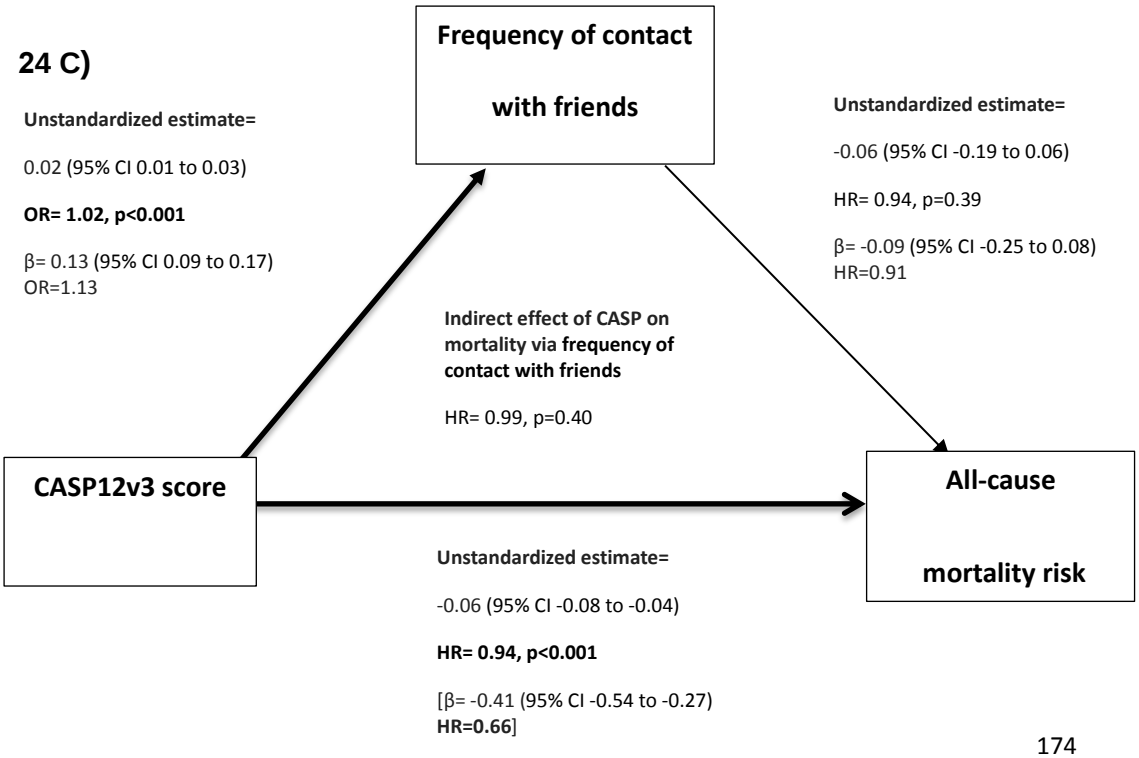
Figures 24B to 24E show that frequency of contact with family, frequency of contact with friends, obesity and physical activity did not serve as significant mediators in the relation between CASP12v3 score and mortality. While the predictor variable (CASP12v3 score) significantly influenced the other proposed mediators and there were significant direct effects of CASP12v3 score on mortality with the presence of these mediators, the indirect effects of CASP12v3 on mortality through each of the mediators, however, were not significant. For example, per one unit increase in CASP12v3 score was significantly associated

with a decrease in hazard of death by factors of 0.94 (P<0.001) and an increase in odds of having frequent contact with family by factor of 1.02 (P<0.001) (See figure 24B). However, the indirect effect, defined as the product of the path coefficient for the effect of CASP12v3 score on frequency of contact with family, and the path coefficient for the effect of frequency of contact with family on mortality was not significant (HR=0.99, P=0.23*)* (see figure 24 B)

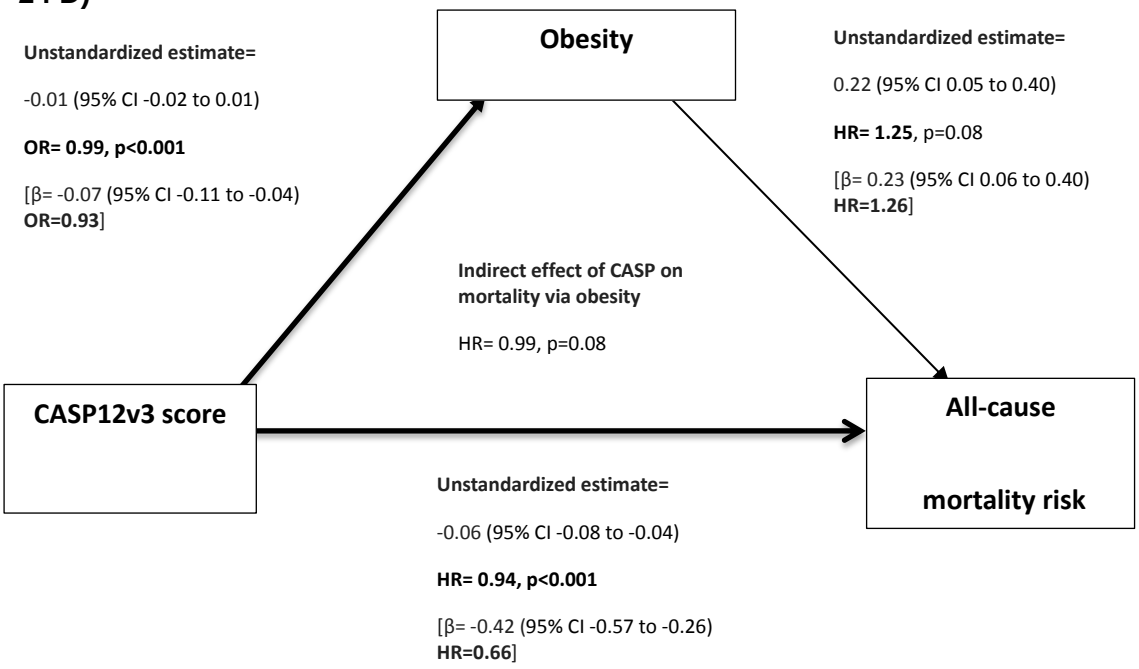
24 B)



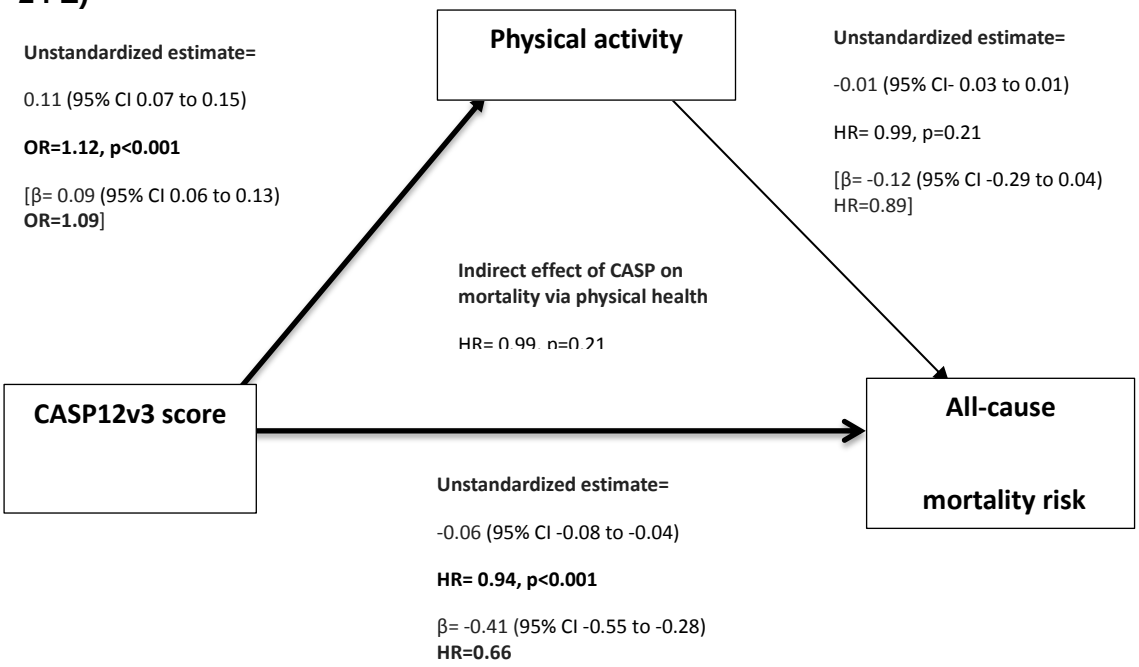
24 C)



24 D)



24 E)



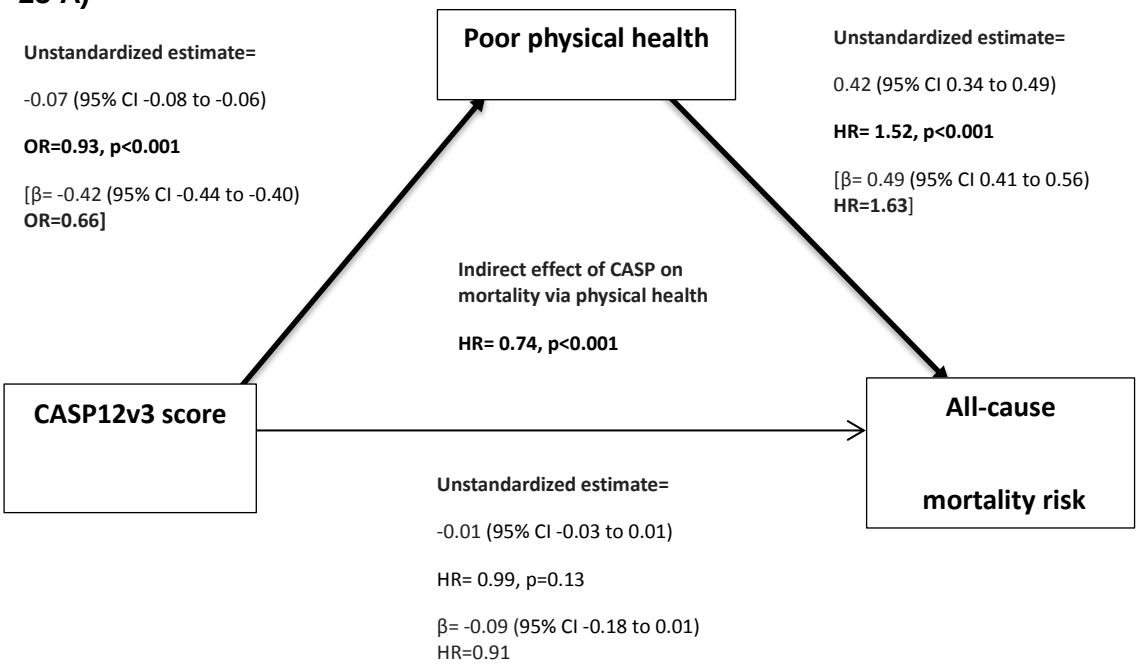
Similarly, in the Russian data none of the proposed mediators except for physical health (figure 25A) significantly contributed to the association between CASP and mortality. The total effect of CASP12v3 score in predicting mortality was significant (HR=0.96, p<0.001), but the direct effect of CASP12v3 predicting mortality was not significant when physical health was also in the model (HR= 0.99, p=0.13), suggesting that the effects of CASP12v3 score on mortality were

fully mediated by physical health (Indirect effect via physical health HR=0.74, P<0.001).

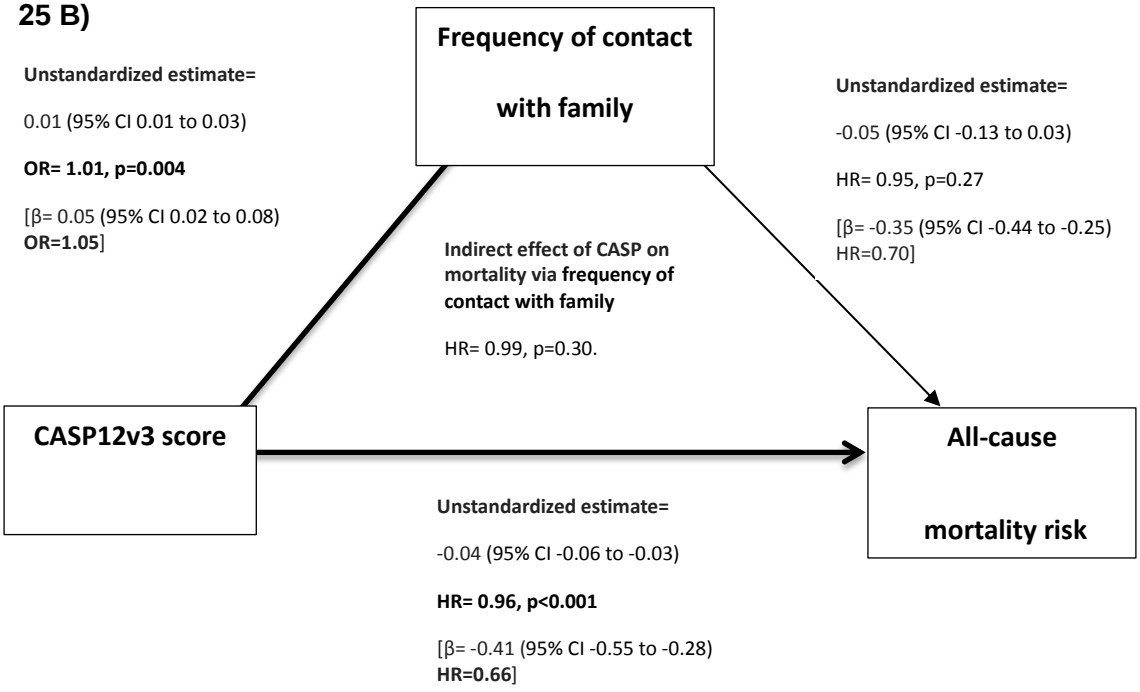
Figure 25 The estimation of the direct and indirect effect of CASP12v3 score on mortality in Russia

Bolded lines indicate significant direct and indirect effects

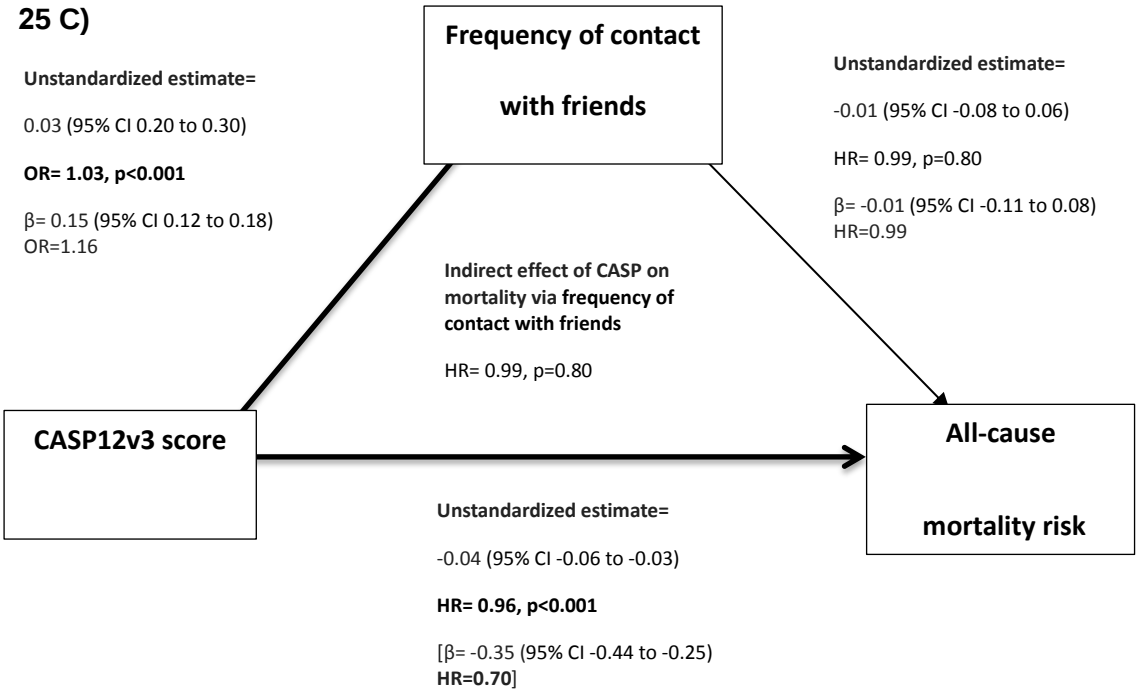
25 A)



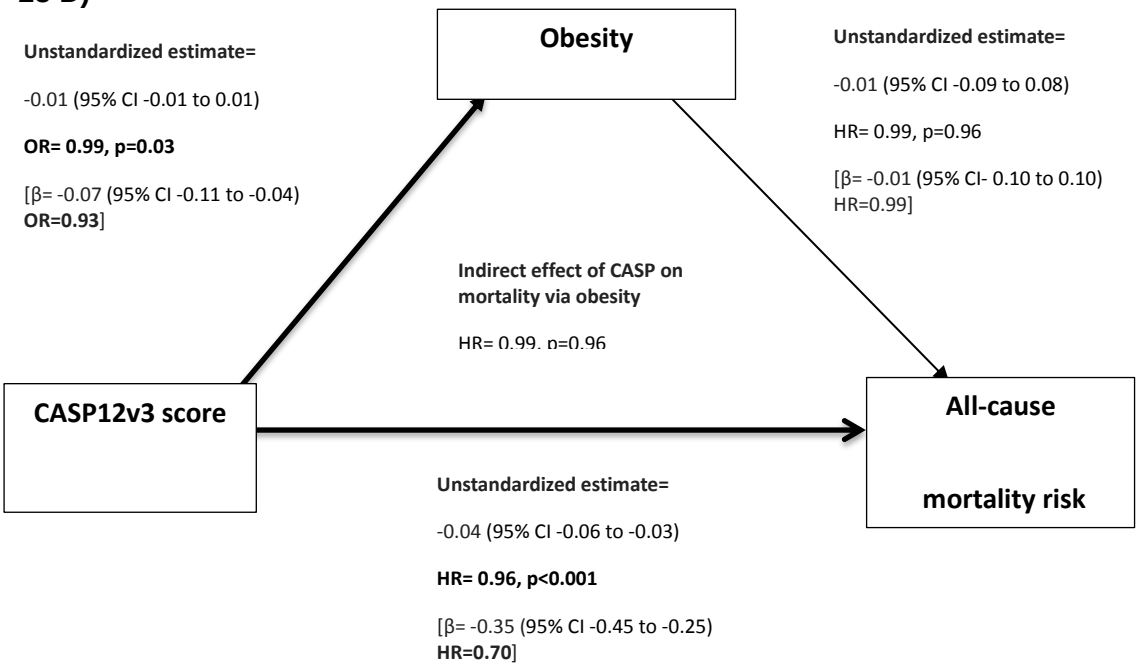
25 B)



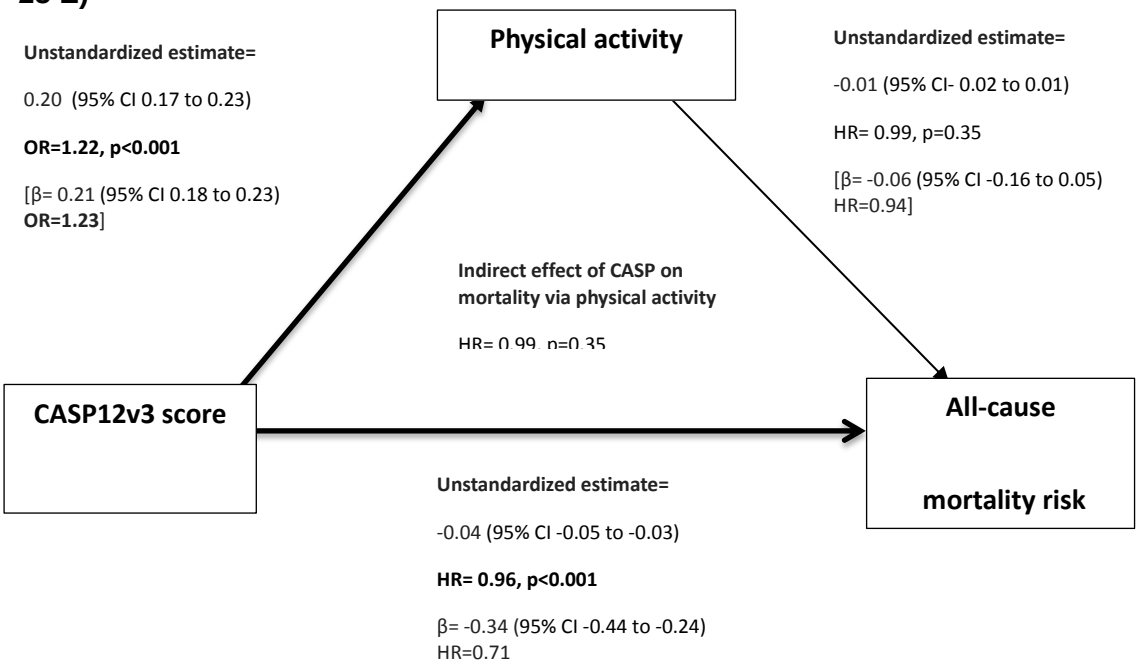
25 C)


Frequency of contact with friends
Unstandardized estimate=
0.03 (95% CI 0.20 to 0.30)
OR= 1.03, p<0.001
β= 0.15 (95% CI 0.12 to 0.18)
OR=1.16
Unstandardized estimate=
-0.01 (95% CI -0.08 to 0.06)
HR= 0.99, p=0.80
β= -0.01 (95% CI -0.11 to 0.08)
HR=0.99
Indirect effect of CASP on mortality via frequency of contact with friends
HR= 0.99, p=0.80
CASP12v3 score
All-cause mortality risk
Unstandardized estimate=
-0.04 (95% CI -0.06 to -0.03)
HR= 0.96, p<0.001
[β= -0.35 (95% CI -0.44 to -0.25)
HR=0.70]

25 D)


Obesity
Unstandardized estimate=
-0.01 (95% CI -0.01 to 0.01)
OR= 0.99, p=0.03
[β= -0.07 (95% CI -0.11 to -0.04)
OR=0.93]
Unstandardized estimate=
-0.01 (95% CI -0.09 to 0.08)
HR= 0.99, p=0.96
[β= -0.01 (95% CI- 0.10 to 0.10)
HR=0.99]
Indirect effect of CASP on mortality via obesity
HR= 0.99, p=0.96
CASP12v3 score
All-cause mortality risk
Unstandardized estimate=
-0.04 (95% CI -0.06 to -0.03)
HR= 0.96, p<0.001
[β= -0.35 (95% CI -0.45 to -0.25)
HR=0.70]

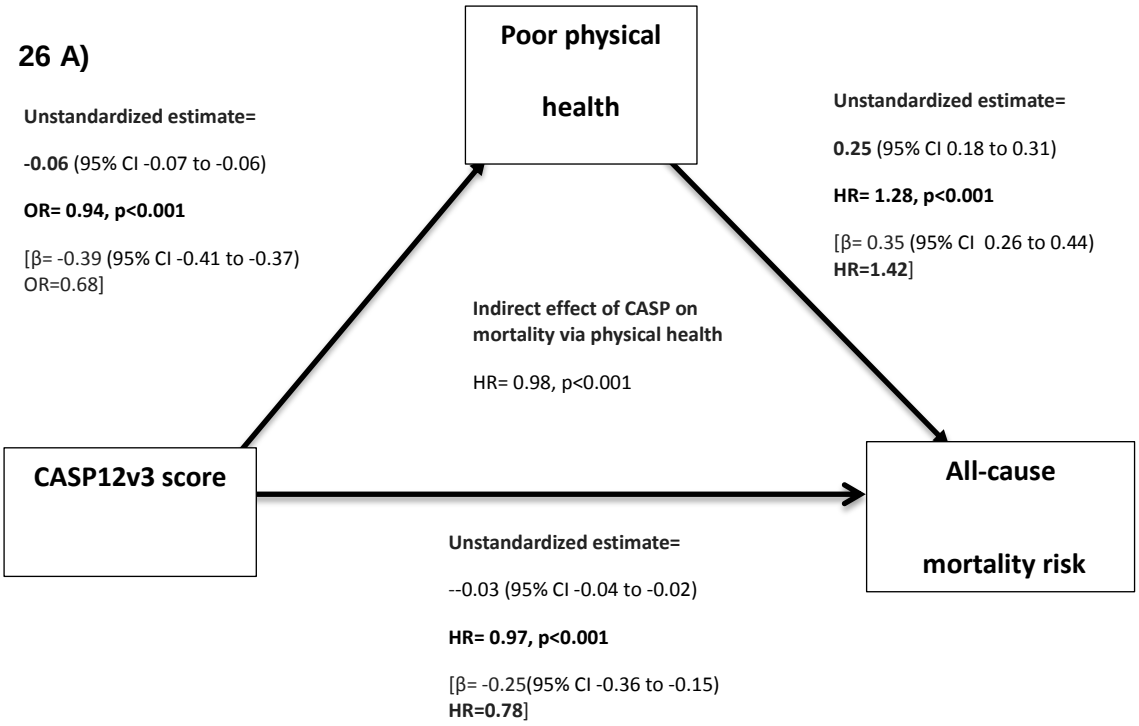
25 E)

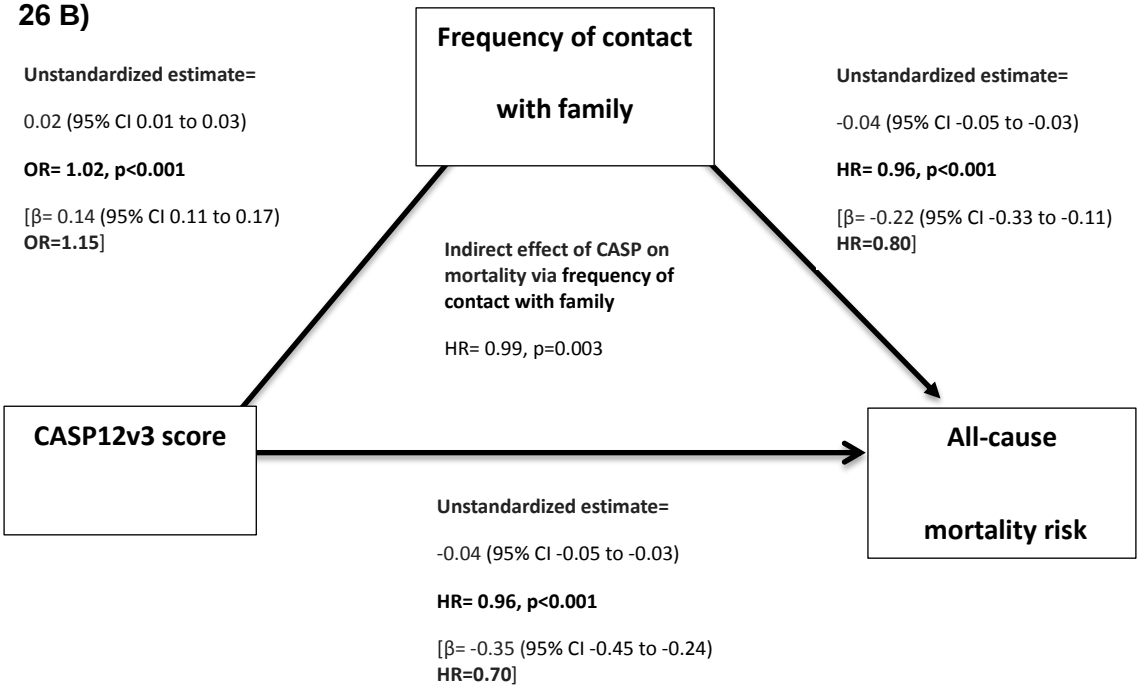


Among Poles, quality of life in later life was found to be negatively related to mortality, after taking into account of all other covariables. Results of simple mediation analysis revealed that the relation between CASP and morality is partially mediated by two intervening variables: Physical health (Indirect effect: HR=0.98, p<0.001) (Figure 26A), and frequency of contact with family (Indirect effect: HR=0.99, P<0.001) (Figure 26B). Notably, the size of the direct effects remained significant in the presence of the mediating variable in each model. This indicated that some of the effect between CASP12v3 and mortality was partly explained by physical health and frequency of contact with family. All other presumed mediators were not significant in predicting all-cause mortality, and indirect pathways were not significant at the 0.05 level.

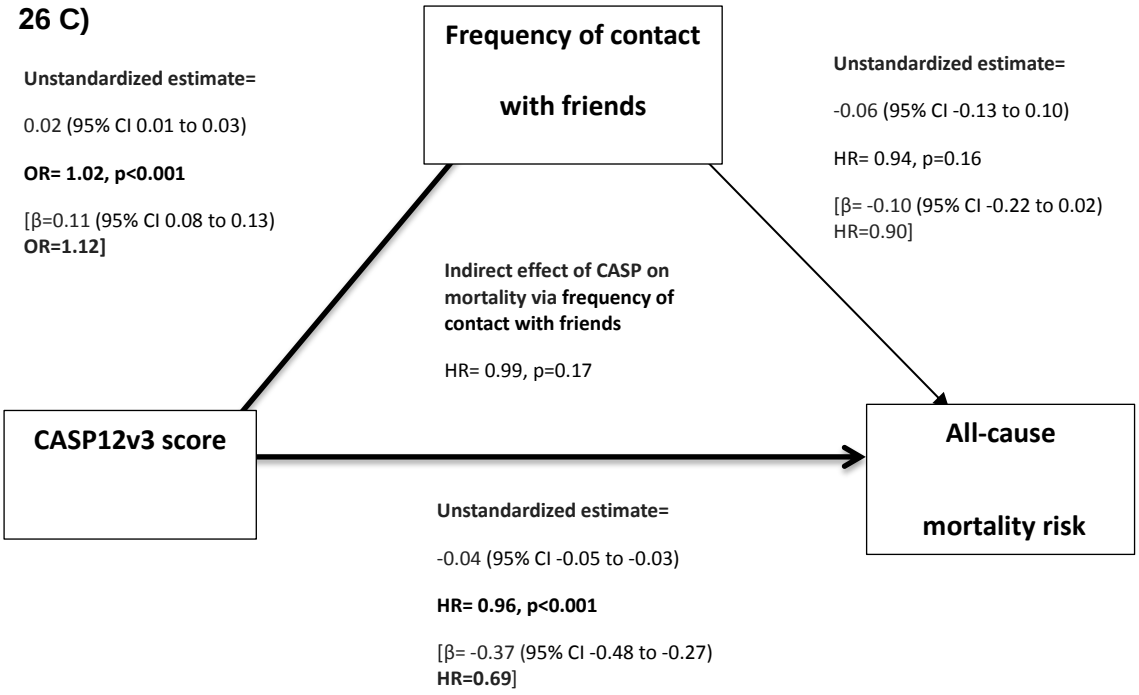
Figure 26 The estimation of the direct and indirect effect of CASP12v3 score on mortality in Poland

Bolded arrows indicate significant direct effects

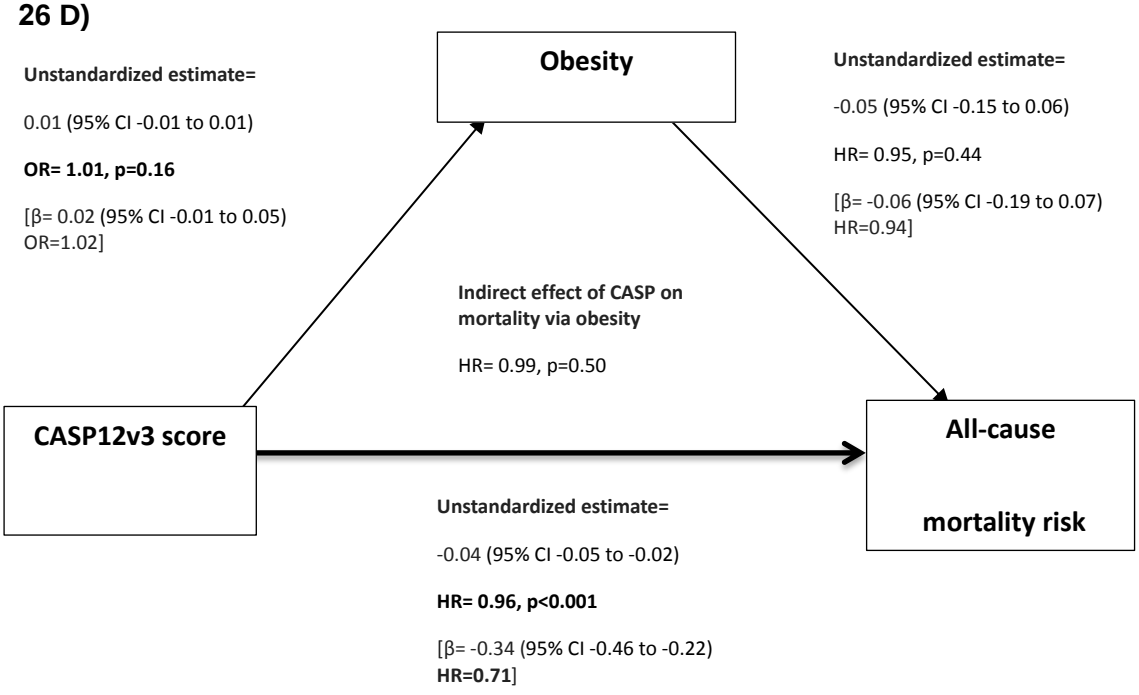




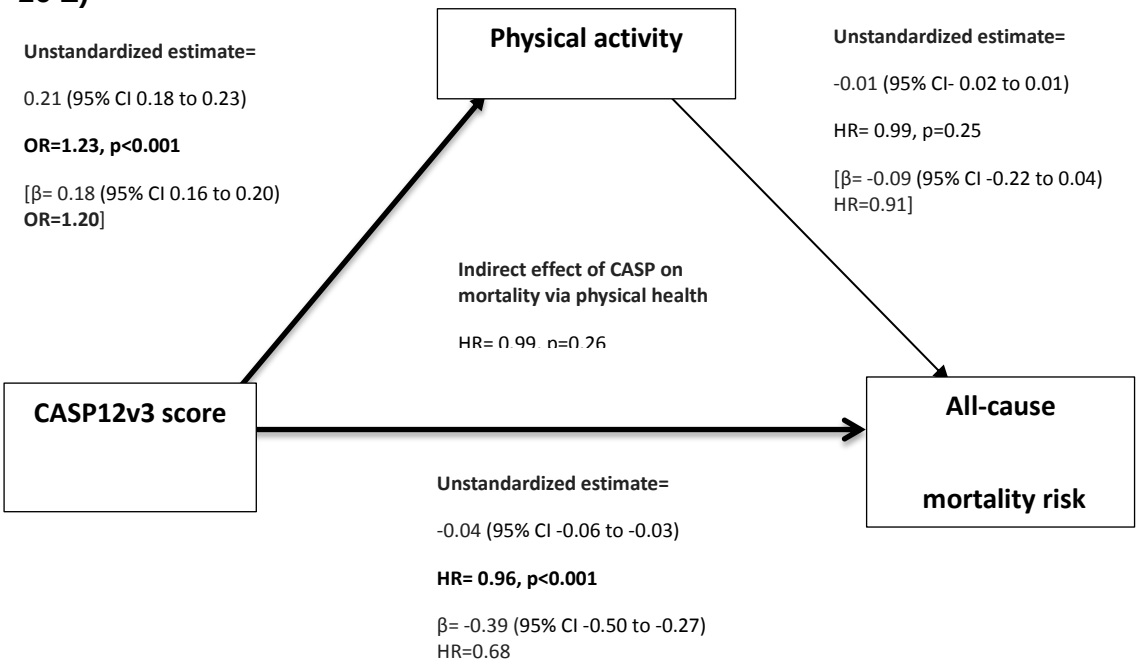
26 C)


Frequency of contact with friends
Unstandardized estimate=
0.02 (95% CI 0.01 to 0.03)
OR= 1.02, p<0.001
[β=0.11 (95% CI 0.08 to 0.13)
OR=1.12]
Unstandardized estimate=
-0.06 (95% CI -0.13 to 0.10)
HR= 0.94, p=0.16
[β= -0.10 (95% CI -0.22 to 0.02)
HR=0.90]
Indirect effect of CASP on mortality via frequency of contact with friends
HR= 0.99, p=0.17
CASP12v3 score
All-cause mortality risk
Unstandardized estimate=
-0.04 (95% CI -0.05 to -0.03)
HR= 0.96, p<0.001
[β= -0.37 (95% CI -0.48 to -0.27)
HR=0.69]

26 D)


Obesity
Unstandardized estimate=
0.01 (95% CI -0.01 to 0.01)
OR= 1.01, p=0.16
[β= 0.02 (95% CI -0.01 to 0.05)
OR=1.02]
Unstandardized estimate=
-0.05 (95% CI -0.15 to 0.06)
HR= 0.95, p=0.44
[β= -0.06 (95% CI -0.19 to 0.07)
HR=0.94]
Indirect effect of CASP on mortality via obesity
HR= 0.99, p=0.50
CASP12v3 score
All-cause mortality risk
Unstandardized estimate=
-0.04 (95% CI -0.05 to -0.02)
HR= 0.96, p<0.001
[β= -0.34 (95% CI -0.46 to -0.22)
HR=0.71]

26 E)



Final mediation model

Final mediation models for each cohort with unstandardized estimate of the direct and indirect effects are illustrated in figures 27, 28 and 29. Each model was estimated by additionally controlling for obesity, physical activity and social relationship variables.

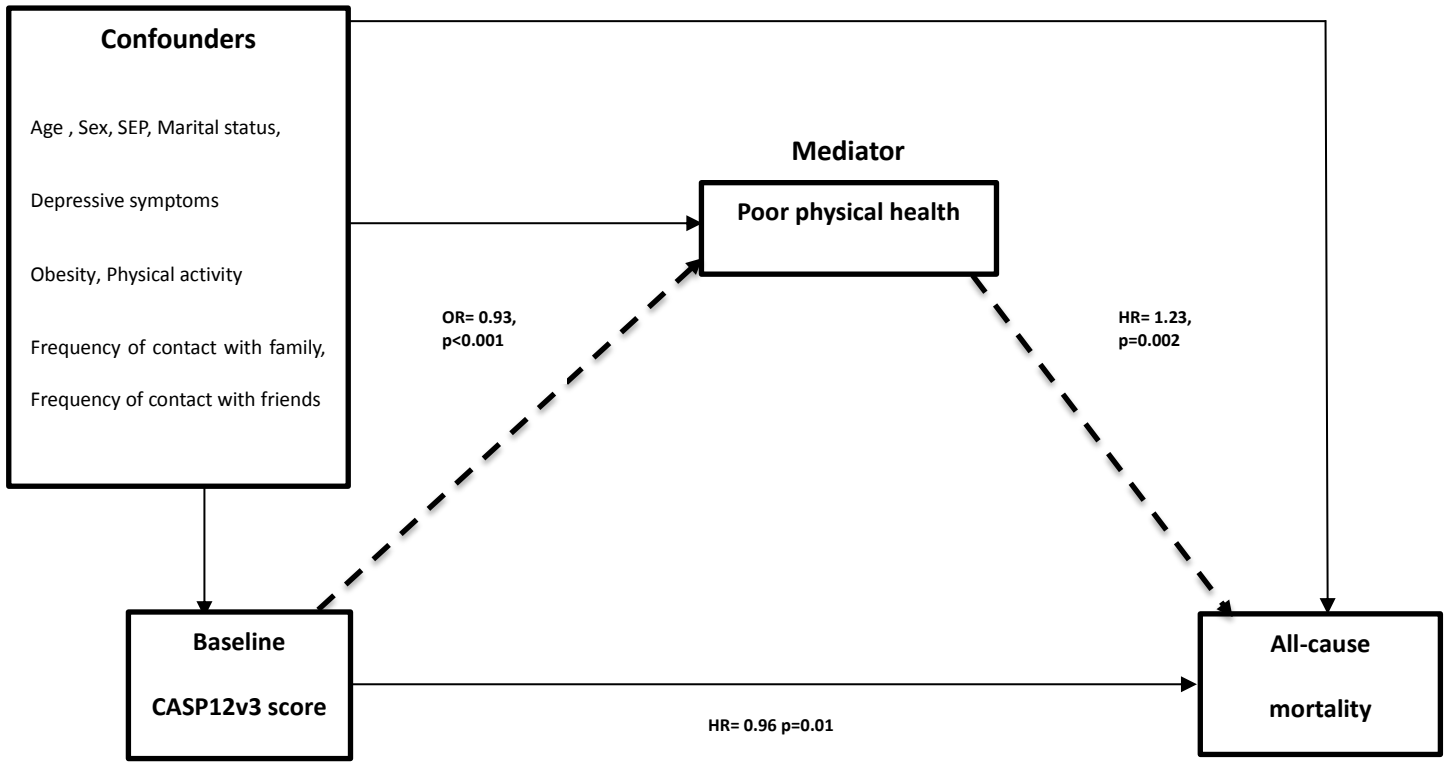
In the Czech Republic, there was a significant direct association between CASP12v3 score and mortality, after inclusion of physical health in the model (HR=0.96, P=0.01); there was also a significant indirect effect via physical health (HR=0.99, P=0.001), with mediated-proportion of around 26.3% (Figure 27). In the Russian data, CASP12v3 score did not have a significant direct effect on mortality risk, but rather was fully mediated by physical health (HR=0.97, p<0.001), with a mediated proportion of 23.1%. Analysis of Polish data confirmed the presence of direct effect (HR=0.97, p<0.001) along with physical heath and

frequency of contact with family as specific mediators in the relationship between CASP12v3 score and mortality risk. In the multiple mediation model, physical health explained around 31% of this association according to the mediated proportion; the proportion of the total effect mediated by frequency of contact with friends was around 6% (Figure 29). These findings indicate that a modest proportion of the impact of CASP on mortality risk is mediated by physical health and frequency of contact with family and there may be additional factors which account for the variance in mortality.

In addition, mediation models were re-estimated using full information maximum likelihood (FIML) method, as implemented in Mplus to yield parameter estimates while adjusting for the uncertainty associated with the missing data. Sensitivity analysis suggests missing data are an unlikely source of bias because the results using the FIML method were virtually same to those reported in the main complete case analysis (results not shown).

Figure 27 Mediation model from baseline CASP12v3 score to mortality showing the direct effects of CASP12v3, the indirect effects acting through physical health, and the proportion of the overall effect due to mediation, in Czech Republic.

Dotted arrows indicate statistically significant indirect effects through physical



Direct effect of CASP12v3 on mortality: HR=0.96, p=0.01

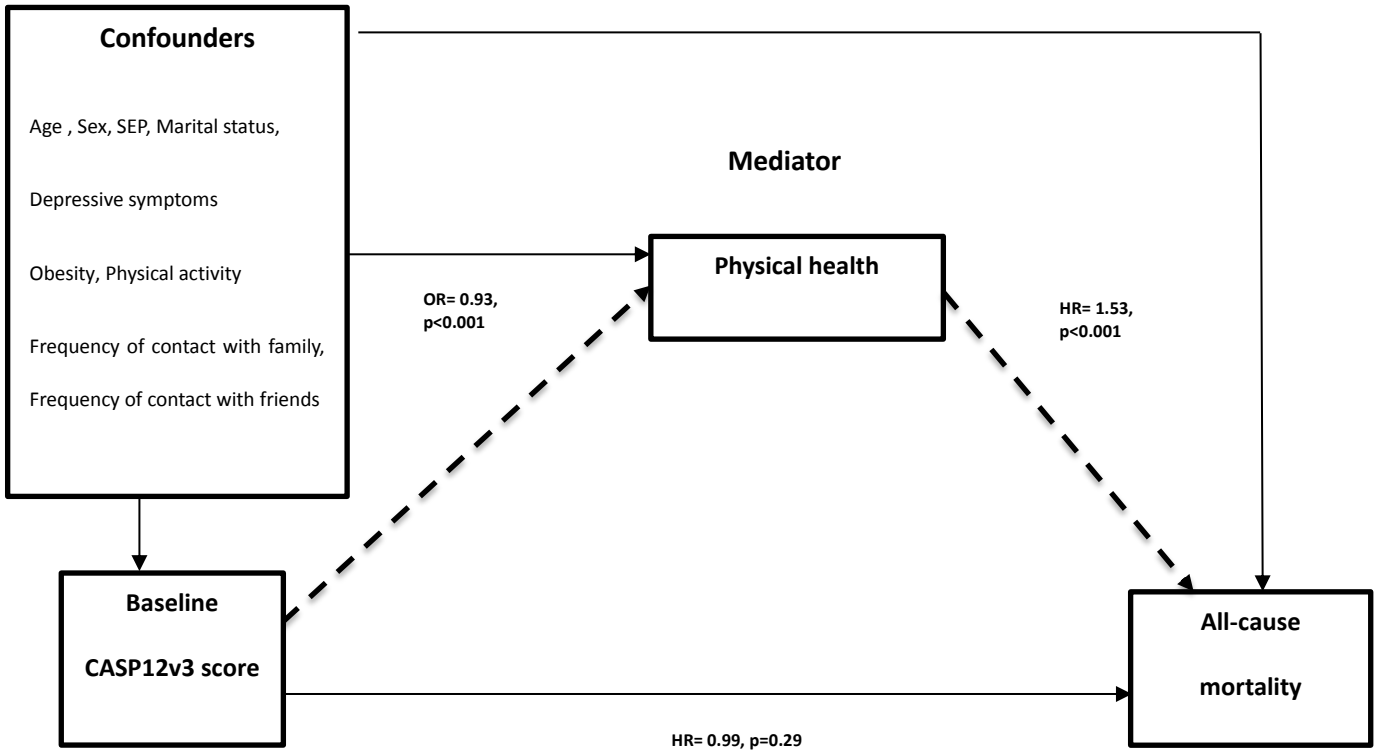
Indirect effect via physical health: HR= 0.99, p=0.002

Total effect of CASP12v3 on mortality: HR=0.94 p<0.001

Mediation proportion via physical health -0.015/-0.057 x 100= 26.3%

Figure 28 Mediation model from baseline CASP12v3 score to mortality showing the direct effects of CASP12v3, the indirect effects acting through physical health, and the proportion of the overall effect due to mediation, in Russia.

Dotted arrows indicate statistically significant indirect effects through physical health.



Direct effect of CASP12v3 on mortality: HR=0.99, p=0.29.

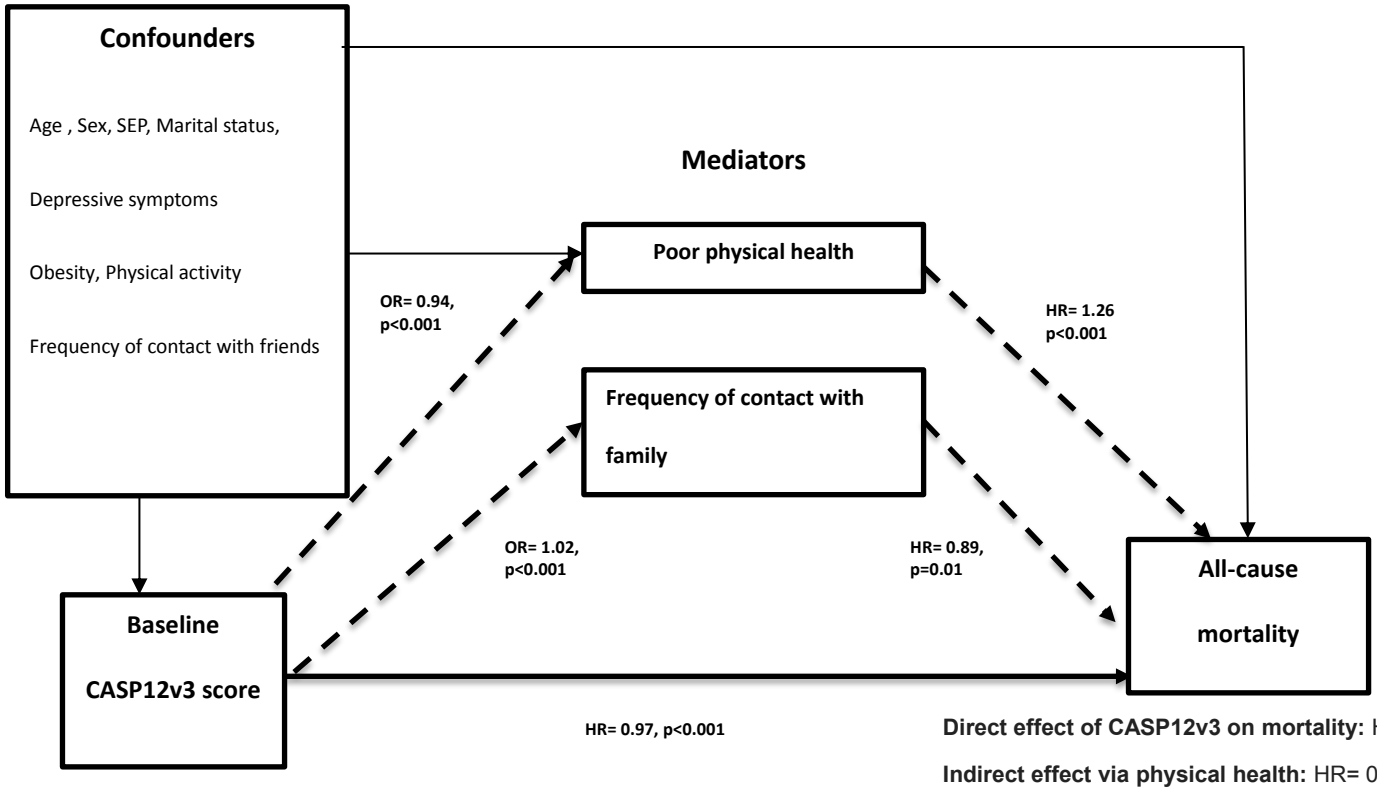
Indirect effect via physical health: HR= 0.97, p<0.001

Total effect of CASP12v3 on mortality: HR=0.96, p<0.001

Mediation proportion via physical health -0.009 / -0.039 x 100= 23.1%

Figure 29 Multiple mediation model from baseline CASP12v3 score to mortality showing the direct effects of CASP12v3, the indirect effects acting through physical health and frequency of contact with family, and the proportion of the overall effect due to mediation.

Dotted arrows indicate statistically significant indirect effects through physical health and frequency of contact with family.



Direct effect of CASP12v3 on mortality: HR=0.97, p<0.001.

Indirect effect via physical health: HR= 0.98 p<0.001

Indirect effect via frequency of contact with family: HR= 0.99, p=0.01

Total effect of CASP12v3 on mortality:

HR=0.95, p<0.001

Mediation proportion via physical health -0.015 / -0.048 x 100= 31.3%

Mediation proportion via frequency of contact with family -0.003/0.048= 6.3%

In summary, to the best of my knowledge, this is the first study to attempt to quantify different potential underlying mechanisms through which higher CASP12v3 scores are associated with lower risk of all-cause mortality. Our results indicate physical health is a significant mechanism by which CASP12v3 score affects the risk of mortality. Although low increased the risk of mortality directly after adjusting for other covariates, physical health serves as an important indirect pathway from CASP12v3 to increased mortality risk. Amongst Czech and Polish older adults, CASP12v3 score had both direct and indirect effects on mortality, which was partially mediated though physical health. In the Russian data an examination of the direct and indirect effects of physical health revealed evidence of full mediation effect.

Chapter 6

Discussion

In Chapter 6, I discuss my findings in the light of range of methodological issues as well as past findings. Firstly, I focus on methodological issues of the study, its strengths and limitations. The study findings are then summarized and reviewed in terms of study aims and objectives and discussed in the light of existing literature. The meaning of the study in terms of its implications for policy is discussed, and possibilities for future work are also outlined.

6.1 Study limitations and strengths and directions for future research

It is important to recognize a number of limitations associated with the current study. One potential limitation regarding the data includes the relatively short follow-up time. Additional follow-up would be desirable because with longer follow-up period, more information about the survival status can be gathered and thus the power to detect the desired effect size will be higher. Second, as in all observational studies, there is a possibility of residual confounding by additional variables which were not collected, that could accounts for both greater quality of life and reduced risk of mortality. The mediators explained a moderate proportion of the association between CASP and mortality, and the direct association still remained significant even after adjusting for all variables in the model. These results suggest that other variables which were not included in analyses may play a mediating role in the relationship between quality of life and mortality. Whilst this project proposed some pathways that are testable in my dataset, several other plausible pathways with differences in directionality of the relationship may

exist. For example, other contributing factors, such as cognitive function, and biological correlates of CASP e.g cortisol and C-reactive protein that were not addressed in this study may potentially confound or mediate the CASP-mortality relationship. Unfortunately, a large proportion of these data were missing for the participants in HAPIEE if collected (such as selection of cognitive measures) or were not available in HAPIEE at all (such as cortisol). Hence it was not possible to conduct analysis using these variables. Therefore, unmeasured confounding factors might have consequently led to either an overestimate or underestimate of the actual relation between CASP and mortality. Furthermore, while the mediation models adjusted for self-reported health status, physical functioning, and the presence of long-term illness, models did not adjust for specific diagnosed comorbidities (e.g cancer). Examination of specific comorbidities would lead to a better understanding of how objective measures of health contribute to the association between CASP score and mortality.

In addition, data on physical health and physical activity in HAPIEE were self-reported, and could be affected by reporting bias. Therefore, great caution must be taken in drawing conclusions from self-report data. However, the centrally designed study protocol for HAPIEE ensures good quality of data and comparability across populations. Also, because the CASP score in HAPIEE was collected from retired participants only, information on quality of life from working non-retired participants were not available. Consequently, respondents included in this project may not be entirely representative of the whole population and the generalization of results of this project may be limited. Additionally, these HAPIEE samples are predominantly urban and extrapolation beyond urban setting requires caution. Thus, future studies including a more heterogeneous group of participants might provide better estimation of quality of life and its links with

mortality.

Furthermore, in survey of older adults, a threat to the validity of survey estimates is unit and item non-response. Unit nonresponse is the failure of a member of the sample to respond to the survey as a whole. Item nonresponse can occur as a result of respondents failing to provide acceptable responses to answer one or more survey items. Non-response can affect both precision and accuracy of parameter estimates, the former relating to the number of people participating, the latter referring to the absence of bias in observed estimates. Results of a study can be influenced by non-response in case of a selection bias if there are systematic differences between non-respondents and respondents. Several studies have previously examined various aspects of differences between respondents and respondents to health surveys. In general, it has shown that compared to non-respondents in population based studies, respondents are, on average, healthier, more likely to have higher socioeconomic position, have lower prevalence of unhealthy life styles and are well socially integrated than are non-respondents (Goudy, 1985, Cohen and Duffy, 2002, Nummela et al., 2011). In the case of this project, there was some evidence that participants are healthier and more affluent than non-responders as illustrated in Appendix 4 (page 215) For example, participants with missing data across CASP-19 items from Czech Republic differed significantly from complete cases with respect to gender, education level, household amenities score, material deprivation, self-reported health status and depressive symptoms. Also, a significant difference was found with regard to mean CASP12v3 scores, such that complete cases had significantly higher mean CASP12v3 scores than did those with missing data. It is therefore likely that participants of the study in this thesis were, in general, healthier than the general populations from which they were selected and the

mean CASP scores in the current study maybe higher than that of the general population. This could have resulted in an under-estimation of the real association between quality of life and mortality. However, sensitivity analysis accounting for missing data by full information maximum likelihood approach yielded virtually same results to the complete-case analysis. Therefore, the possible selection bias due to exclusion of participants with missing data and the resulting potential underestimation of the strength of the association between CASP and mortality were unlikely to be substantial. Moreover, low response rates in surveys do not necessarily cause selection bias; however, in general the lower the response rate, the greater the probability that those who responded are not randomly selected, and this may introduce bias into survey results. In the HAPIEE study, the overall response rate was not very high (59%) but comparable to that of other population based studies in this age group (Khaw et al., 2001, Shkolnikova et al., 2009, Ahnquist and Wamala, 2011, Börsch-Supan et al., 2013).

Particular strength of this project is the use of large prospective samples. No better individual level datasets are presently available for the assessment of quality of life and all-cause mortality in CCEE/FSU populations. Another strength of this project comes from the use of the CASP instrument, which is a theoretically sound construct of quality of life that has been validated in several surveys in the UK and in other parts of Europe and Asia. To my knowledge, this It is the first study that has psychometrically validated the CASP in large sample of older adults from CCEE. The good internal consistency of the CASP12v3 items indicated that this measure of quality of life has suitable psychometric properties in this cohort to be used as a summary scale of quality of life. Also, the present investigation of the prognostic value of CASP data on survival is the first empirical demonstration of such prediction in the CCEE region.

Further strength of this project comes from the control for a wide range of potentially confounding factors, and the use of various statistical methods such as structural equation modeling (SEM) and Cox regression to assess the relationship between CASP score and mortality and identify potential pathways underlying it. As Cox regression models the time to event, it is more efficient and statistically powerful than using dichotomous outcomes in logistic regression (Cuzick, 1982, Green and Symons, 1983, Annesi et al., 1989). Proportional hazard within an SEM framework is an innovative statistical technique which enables analysis of mediation effects, using censored data. This technique has been applied to substantive research (Ploubidis and Grundy, 2009, Hill et al., 2011, Hagger-Johnson et al., 2012, Turiano et al., 2012). An advantage of SEM over more traditional methods for assessing mediation is that SEM accommodates simultaneous analysis of multiple structural relationships between variables; and the capability to decompose total effect into direct and indirect effects to provide formal significance tests of mediation effects.

However, inferences regarding cause and effect relations may be limited due to the fact that both the CASP12v3 score and mediators were measured at the same time-point. Possibly, a decline in physical health leads to a lower level of quality of life, subsequently resulting in higher risk for death. The assessment of the determinants of CASP12v3 score was also cross-sectional in nature and it was not possible to infer causality between different risk factors and CASP. Hence, the results of this study must be corroborated by future longitudinal studies, using multiple measurements of the mediators and exposure. Longitudinal mediation models will permit the examination of different mediation effect that cannot be established using the cross-sectional mediation model, such as whether a mediated effect is stable over time or ascertain the temporal link

between exposure, covariate and outcome variables. This will lead to more accurate conclusions about mediation effects and facilitate the development of more targeted and efficient interventions to foster longevity at older ages. Alternative approaches such as latent growth modeling, autoregressive and multilevel modeling can be used in future studies for longitudinal mediation analyses with SEM (Lockhart et al., 2011, Selig and Preacher, 2009)

Besides, SEM requires a set of stringent assumptions to make valid causal inferences, such as no unmeasured confounding between exposure–mediator, no unmeasured confounding between mediator–outcome, and no unmeasured confounding between the exposure–outcome relationship (De Stavola et al., 2015). In general, as individuals in observational studies are not randomly assigned to levels of the mediator, confounders of the mediator and outcome may exist that limit causal inferences, despite controlling for numerous confounding variables. During recent decades, more flexible approach using additive hazard model within the counterfactual framework has been proposed as an alternative method for quantifying mediating effect (VanderWeele, 2011, Lange and Hansen, 2011, VanderWeele, 2015). Notably, this method allows for interactions between exposure and mediator variables. Future studies should consider adopting this approach for better assessment of mediation effects.

There has been little research on the changes of CASP over time (Howel, 2012, Webb et al., 2010). Currently, new data collection for HAPIEE started in Russia which will allow prospective assessment of the changes in CASP score over the period of approximately 11 to 12 years. The extended follow-up period and larger

number of mortality cases will increase the statistical power in assessing the relationship and help obtain more reliable estimate of long-term effects of quality of life on survival. Also, given the small number of events, the present study was not able to analyse mortality from cardiovascular disease or cancer. Future studies should involve exploring the cause-specific mortality risks associated with low quality of life. Furthermore, because this is the first report of mediating role of social relationship variables in the relationship between CASP and mortality, replication in other prospective population-based samples is crucial. Future research should investigate the applicability of the proposed analytic framework of this project to other datasets, for example, amongst different sample of older adults living in other welfare regimes.

6.2 Comparison of findings with previous literature

The findings of this project related to each study hypothesis are briefly summarized below and placed into the context of the existing literature.

6.2.1 Association between CASP and later-life mortality.

In this large prospective cohort study of older adults aged 50 or over living in CCEE, CASP12v3 score was found to be predictive of all-cause mortality on follow-up. The associations were independent of a range of potential confounding factors, including depressive symptoms, obesity, physical activity, marital status, SEP , age and sex. There were also no statistically significant differences in the associations between men and women.

Hypothesis 1 was partially supported by findings of this research: There was evidence of strong graded relationship between CASP12v3 tertile scores and mortality, independently of age, sex, marital status, SEP, obesity, physical activity, and symptoms of depression. Czech older adults with CASP12v3 scores

in the intermediate tertile had 45% increased risk for death while those in the lowest third of CASP12v3 score tertile had 75% increased risk for mortality compared to those in in highest (richest) tertile (P for trend p=0.01). Russians in the intermediate CASP12v3 tertile had a 15% increased risk of death (HR 1.15, 95% CI, 0.92 to 1.44) while those in the lowest tertile were 70% as likely to die compared to participants in the highest tertile (HR 1.70, 95% CI, 1.35 to 2.13). In Poland, low quality of life was also associated with an increased risk of death (HR 1.12, 95%CI 1.08 to 1.46 for intermediate tertile ; HR 1.43, 95% 1.08 to 1.89 for lowest tertile, versus highest tertile, p for trend 0.03).

An important issue in studies of the relationship between positive well-being and health outcomes is the role of depression and other negative affective states. Depressed mood is known to be associated with coronary heart disease, diabetes, cognitive disorders and other health conditions including mortality (Ariyo et al., 2000, Knol et al., 2006, Spira et al., 2012), and correlates highly with CASP . In the Cox regression analyses, the protective effect of CASP remained significant even after controlling for symptoms of depression. Thus the effect of CASP on mortality does not merely mirror the known adverse effects of depression.

However, when physical health variables were incorporated in the successive Cox regression models for further adjustment, the significant impact of low quality of life on all-cause mortality attenuated. These findings suggested that the association between CASP12v3 score and all-cause mortality is largely mediated by physical health, as indicated by attenuation and loss of significance for the hazard ratios. The significance of mediation effect of physical health in the relation between CASP and all-cause mortality was further confirmed in mediation analyses using structural equation modeling.

Similar to findings of this study concerning mortality, numerous other studies found that self-rated HRQOL scores is independently predictive of mortality. The majority of previous studies have focused on the association between HRQOL and mortality in diseases-specific populations and few studies have focused on the general populations. For example, data analysis of the Dialysis Outcomes and Practice patterns Study revealed that lower scores for major components of HRQOL (both physical and mental health) are strongly associated with a higher risk of death and hospitalization in patients undergoing hemodialysis, independent of a series of demographic and comorbidity variables (Mapes et al., 2003). In a study of 711 patients with peripheral artery disease in the Netherlands, Issa et al (2010) demonstrated that HRQOL, as measured by the EuroQol Questionnaire (EQ-5D) is strongly associated with long-term survival after vascular surgery. In this study, poor HRQOL remained an independent predictor of mortality after controlling for other risk factors, with the risk being 5-fold compared to patients with a good HRQOL. In another cohort of 5,256 community-dwelling older adults in Italy, the EQ-5D independently predicted all-cause mortality and first hospitalization (Cavrini et al., 2012). In a prospective cohort study of 1,529 Chinese community-dwelling older adults, lower total HRQOL score, was associated with a significantly increased risk of 10-year all-cause mortality, after adjusting for socio-demographic variables, dietary and behavioural risk factors, and comorbidities (HR=1.44, 95% CI 1.00 to 2.06) (Xie et al., 2014). Xie et al 2014 found that the independence (including daily need for medicines or treatment, satisfaction in independent living ability, difficulties in performing physical activities) domain scores (HR = 1.66, 95% CI: 1.13-2.42), Psychological (self-confidence, living pleasure, nervousness, negative feeling, memory, and attention span) (HR = 1.47, 95% CI: 1.03-2.09) and Environmental (financial

status and condition of residence) domain scores (HR = 1.43, 95% CI: 1.003-2.03) are also significantly associated with all-cause mortality.

In a meta-analysis of 35 prospective studies, Chida & Steptoe (2008) reviewed the association between greater positive well-being and reduced risk of mortality in both healthy populations (combined hazard ratio (HR) = 0.82; 95% CI = 0.76 to 0.89; p <0.001) and in those already ill at baseline (combined HR = 0.98; 95% CI = 0.95 to 1.00; p = 0.030). In all of these studies, apart from one study where there was no control for the potentially confounding effect of depressive symptoms, the protective effect of positive wellbeing persisted after adjustment for negative affect, and this implied that the effect of positive well-being on mortality is independent of negative affect (Chida and Steptoe, 2008).

Recently, in an analysis of the English Longitudinal Study of Ageing, Steptoe et al (2014) found that eudemonic well-being, assessed by CASP-19, is associated with increased survival; 29.3% of people in the lowest well-being quartile died during the average follow-up period of 8.5 years compared with 9.3% of those in the highest quartile. Compared with the lowest quartiles, the highest quartile of well-being was associated with 58% reduction in risk (95% CI 16.7 to 63.8) after adjustment for age and sex. After controlling for other covariates, this effect attenuated to 30% reduction in risk (95% CI 16.0 to 41.7), but the associations remained significant and were independent of age, sex, demographic factors, and baseline mental and physical health (Steptoe et al., 2014).

Using a large study of 10,291 British older adults age 40 years or older from the British Household Panel Survey, with a follow-up of 5 years, Netuveli et al. (2012) have demonstrated that higher quality of life is associated with better survival using CASP-19. In this study, below average QOL predicted mortality; compared

with a mortality of 12/1000 person-years in those having average QOL (CASP score 29.4-45.8), those with below-average QOL had more than twice (27/1000 person-years) and those above average had a third less (8/1000 person-years) mortality. This association remained significant even after controlling for various covariates such as age, sex, socioeconomic position, household income, self-rated health, limiting long-standing illness and medical conditions. Separate examination of the CASP-19 domains showed that the crude associations of the four domains with mortality are all significant. High scores of control, pleasure and self-realisation were protective against mortality, while high scores of autonomy were positively associated with mortality. However, when adjusted for the covariates, only control and self-realisation domins remained significant. One unit increase in the control domain score was associated with 9% decrease in probability of death while the self-realisation domain showed a 7% reduction in mortality risk for each unit change in the score. Findings of this project demonstrated that in unadjusted analysis, higher scores of total and all four domains of CASP-19 are associated with a lower risk of death, with hazard ratios ranging between 0.95 and 0.97. In HAPIEE, the specific domains of CASP-19 most associated with survival were autonomy and control, in Russia and Poland respectively for both genders. In the Czech Republic, survival was most strongly predicted by the pleasure domain in men (HR=0.86; 95% CI 0.81 to 0.91) and self-realisation domain in women (HR=0.86; 95% CI 0.81 to 0.92) (See appendix 1 page 212) However, most multivariable-adjusted hazard ratios for all-cause mortality were not significant and only the pleasure domain in the Czech Republic and the Control domain in Poland were uniquely associated with survival, after controlling for other covariates.

In line with previous research, findings of this project revealed an inverse graded

association between CASP12v3 score and all-cause mortality; persons who were in the bottom tertile of CASP12v3 score had the highest mortality, followed by people in the intermediate tertile. Individuals in the top tertile were best off. For example, Czechs in the bottom CASP12v3 tertile had an age-standardized mortality rate (ASMR) per 1000 person-years at risk of 45% for males and 11.7% for females compared with 13.5% for males and 5.1% for females in the top tertile. Although the magnitude of inequalities varied between countries, the direction and graded pattern of the association between CASP12v3 and all-cause mortality was similar in all three countries. The overall mortality rates and the absolute differences in mortality between groups were the highest in Russian men, with a mortality difference between the bottom and top tertile of CASP12v3 of 18.3 per 1000 person-years and overall mortality rate was 49.7%. On the other hand, absolute differences among Russian women were comparable with those in Czech Republic and Poland. The absolute mortality rate for Russian women was 14.2%.

6.2.2 Possible mechanisms linking CASP and subsequent mortality in HAPIEE

The present study aimed to provide insights into the mechanisms underlying the links between quality of life in early old age and mortality in later life. **Hypotheses 2** related to the second research objective, namely that CASP has a direct influence on the risk for mortality, after controlling for the effects of age, gender, marital status, socioeconomic position and depressive symptoms, were supported. SEM showed that, in each cohort, there is evidence that quality of life in old age has significant direct effects on mortality independently of other variables in the model. Moreover, analysis of the HAPIEE data demonstrated that a modest proportion of the important association between quality of life in old and mortality in later life is mediated by physical health in each cohort; additionally,

frequency of contact with family among Poles represented a significant indirect pathway from quality of life to mortality

Currently, mechanisms through which CASP and other measures psychological wellbeing might influence the risk of mortality are not fully understood (Steptoe et al., 2009). However, several mechanisms may contribute to the explanation why those who report high quality of life are protected against all-cause mortality. One potential mechanism is through better health behaviours because affective states are known to be related to health behaviours (Kiecolt-Glaser et al., 2002, Pasco et al., 2011, Gardner et al., 2014). For example, people with a higher positive affect are more inclined to watch their weight, are more perceptive of symptoms of illness, engage more often in activities such as sports, and tend to be moderate with smoking and drinking. Previous analyses using the ELSA cohort have shown that higher CASP-19 scores are associated with being more physically active and with a lower likelihood of smoking. In HAPIEE data, when I tested for the mediating effects of physical activity level and obesity, these variables did not have significant mediating role in the associations between CASP and mortality. Another possible mechanism is an indirect effect of positive psychological well-being, possibly through favorable biological responses, including low cortisol levels, faster cardiovascular stress recovery, reduced inflammation, and resilience to infection. Higher levels of psychological wellbeing have been shown to be associated with lower concentrations of inflammatory markers and cortisol (Steptoe et al., 2009). There is some evidence from prospective studies showing that higher levels of inflammatory markers or a higher ratio of cortisol to dehydroepiandrosterone sulphate may be risk factors for all-cause mortality (Ohlsson et al., 2010, Phillips et al., 2010). A previous study using wave 4 ELSA data reported significant associations between higher levels

of quality of life, measured by CASP-19, and lower blood levels of the inflammatory markers, C-reactive protein and fibrinogen, and higher blood levels of dehydroepiandrosterone sulphate in men (Steptoe et al., 2012b). In the baseline of HAPIEE, complete information on concentrations of cortisol, C-reactive protein, or dehydroepiandrosterone sulphate were not available for study participants and this precluded assessment of the biological processes involved in CASP and all-cause mortality relationship.

The current study found that CASP12v3 scores influence all-cause mortality both directly and indirectly with the mediation of physical health. To date there have been no empirical studies that have investigated the mediating effects of physical health in the relation between CASP score and mortality. However, a eudaimonic measure of well-being has been shown to predict multiple indices of physical health, including subjective health, chronic conditions, symptoms, and functional impairment, over a follow-up of 9- to 10-years (Ryff et al., 2015). Numerous prospective studies and meta-analyse have demonstrated the existence of a longitudinal association between self-rated health mortality (Heistaro et al., 2001, DeSalvo et al., 2006). Additionally, findings of mediation analyses presented in this project indicated that social relationship, i.e. frequency of contact with family contribute to the explanation of association between CASP. Accordingly, presence of relationship with family appears to help lower quality of life groups to enhance their survival. The quantity as well as quality of social interactions has been shown to be associated with well-being (Cohen, 2004, Fiorillo and Sabatini, 2011). Regular contact with family may be beneficial for health and survival in a number of ways, for example it may be a source of emotional and social support and it may enable access to healthcare. Also social relationship may help promote a healthier lifestyle, thus ensuring that healthy behaviours are adopted.

There is also evidence to suggest that regular social contact helps to cope with psychosocial stress and anxiety through provision of emotional support and also by acting as a source of self-esteem (Holt-Lunstad et al., 2010, Fiorillo and Sabatini, 2011).

Further, the strength of the relationship between CASP and morality varied across cohorts. Overall, the relative differential between low and high quality of life groups, in the risks of all-cause mortality, was largest in the Czech Republic compared with Poland and Russia. It is possible that different welfare regime types in these countries might have differentially influenced the relationship between CASP and all-cause mortality. Previously Netuveli et al (2007) used multi-level models to test whether welfare regimes and their characteristics explain the cross-national differences in CASP12v1 scores. They found that the social-democratic welfare regimes were associated with high quality of life, followed by the conservative and liberal types. Mediterranean and post-communist regimes (Czech Republic and Poland) were similar. The former USSR welfare regime types, represented by Russia, were associated with the lowest QOL. 63% of variation between countries could be explained by typology of welfare regime (Netuveli et al., 2007). Post-communist countries and the FSU shared a similar beginning after communism fell in 1989, but then diverged dramatically in political and economic outcomes, including level of economic development, experience of democracy and religious heritage. While the more developed, democratic and Westernized countries of CEE have maintained a high level of social protection that makes them comparable to other EU countries, the states of the FSU have experienced a disintegration of their social safety nets. Poland, for example, spends a large proportion of its national income (about 12% in 2009) on pensions, while Czech Republic and Russia spend around 8 to 9% of Gross Domestic Product (GDP) on public pension. Also, public social spending in

Russia tends to be lower than in most OECD countries. Total health expenditure in Russia was estimated at around 6% of GDP in 2009. This compares with an OECD average of 10% (Organization, 2013, Pensions, 2013). Hence, welfare regime types and related social provision and pension mechanisms implemented in these countries might differentially impact quality of life and influence its relationship with all-cause mortality.

6.2.3 Psychometric properties of CASP

One of the subsidiary objectives of this project was to evaluate the psychometric properties of the CASP scales in sample of older adults aged 50 or over living in Central and Eastern Europe. The findings from the psychometric analysis provide evidence of reliability and validity of the CASP12v3 as a valid, reliable and suitable summary measure of quality of life in old age for use in the HAPIEE cohort. This large population-based study in Central and Eastern Europe is the first validation study of CASP scale in this population group, which includes a general population sample in Russia, Poland and the Czech Republic.

Given the mortality crisis, higher levels of cardiovascular diseases, and the high prevalence of unhealthy behaviours in Russia (Bobak et al., 1999, Bobak et al., 2002, Bobak et al., 2004, Netuveli et al., 2012), mean CASP-19 scores were expected to be lower in Russia than in the Czech Republic or Poland. In both genders, the mean score of CASP-19 were the lowest in Russia (men 34.5, 95% CI= 34.0 to 35.0; women 33.1, 95% CI=32.8 to 33.4), while Polish men (Mean=38.0 95% CI= 37.7 to 38.4) and women (Mean=36.8, 95% CI= 36.5 to 37.1) reported the highest CASP-19 scores. These scores are significantly lower than the mean CASP-19 score reported for the English Longitudinal Study of Ageing (mean 42.5; 95% CI= 42.3 to 42.7) (Netuveli et al., 2006) or the The Irish

Longitudinal Study of Ageing (mean 43.8, 95% CI= 43.6 to 44.1) (Layte et al., 2013). In the Taiwanese study, Wu et al (2013) reported a mean CASP-19 score of 38.2, which is compatible with the mean score of the study sample. In the Brazilian study, mean CASP-16 scores were 31.9 and 35.4 respectively for men and women (Lima et al., 2014).

Score distribution of CASP-19 in HAPIEE showed a skewed distribution for almost all 19 items. Consequently, the ceiling effect was high which indicated the full range of the scale was not captured. High ceiling effect can affect the responsiveness of the CASP questionnaire (Terwee et al., 2007), which reduces the scale's ability to discriminate amongst degrees of better quality of life. However, reliability assessment demonstrated that the overall CASP12v3 score and its subscales had high internal consistency, with coefficients of 0.76 for Czech Republic and Russia, and 0.80 for Poland. With the exception of control/autonomy domain in the Czech Republic (α = 0.64), all subscale coefficients were close to or above 0.70, which is in line with coefficients reported by Wiggins et al (Wiggins et al., 2008).

Consistent with the existing literature, confirmatory factor analysis (CFA) of CASP-19 in HAPIEE did not provide evidence of good fit for the second-order model; RMSEA values were all above or equal to 0.10; CFI and TLI values were below 0.90, which indicated unsatisfactory model fit for the data. For example, the goodness-of-fit indices indicated only an acceptable model in the Czech and Polish samples (Czech Republic: CFI= 0.96, TLI=0.94, RMSEA=0.08; Poland: CFI=0.96, TLI=0.95, RMSEA=0.07 for CASP12v2) and a marginal model fit for Russia (CASP12v2: CFI= 0.86, TLI=0.82, RMSEA=0.16). These results

suggested the CASP scales could be revised further to achieve better model fit (Hu and Bentler, 1999). Alternatively, two-factor model composed of Control/Autonomy and Self-realisation/Pleasure factors including error correlations between negative items were tested using CASP12v3. **Hypothesis 3.1** was confirmed by the findings showing that the CASP12v3 has a good fit to the data in Czech Republic (CFI=0.98, TLI=0.97, RMSEA = 0.05, WRMR=1.65) and satisfactory model fit in Poland and Russia (Poland CFI=0.96, TLI=0.94, RMSEA = 0.07 WRMR= 2.70; Russia CFI=0.93, TLI=0.90, RMSEA = 0.08, WRMR= 3.04). Goodness-of-fit indices for the two-factor structure were substantially better than the second-order models while, the single-factor measurement model of CASP12v3 fit the data equally well.

It is difficult to compare results in this thesis to other CEE/FSU data, due to lack of similar local studies. However, the results of CFA in **Chapter 5.2** are in agreement with the evidence from U.K studies. For CASP12v2, the goodness-of-fit indices of the latter two models are of a similar magnitude as that found by and Wiggins et al. 2008 (British Household Panel Study wave 11 CFI= 0.91; TLI=0.96; RMSEA=0.07). Also, CFI and TLI values for CASP12v1 are comparable to Vanhoutte's work on CASP using ELSA wave 1 participants (CFI= 0.94; TLI=0.93; RMSEA=0.09) (Vanhoutte, 2012). In regards to CASP12v3, the goodness-of-fit indices are in accordance with results reported by Sexton et al. 2013 (Two-factor model: CFI= 0.99, TLI= 0.99, RMSEA= 0.03, WRMR=1.76).

CFA of the proposed measurement models revealed that the Russian data demonstrated somewhat poorer model fit than Czech and Polish data. This discrepancy in results across HAPIEE populations may be attributed to issues

surrounding translation artefact, cultural relevance of certain CASP items, and variation in the interpretation of items across respondents of different cultures (Ramirez et al., 2005). In addition, although the countries of CEE/FSU share some socioeconomic and political characteristics, the analysed group of countries is heterogeneous in terms of their geography, natural resources, democratic structure and developmental trajectories. Historically, governments in these countries followed different overall socio-economic transformation policies after the collapse of communism in 1989: shock therapy in Russia and more social-liberal approach in the Czech Republic and Poland. There is also divergence in range of health indicators, such as life expectancy or CVD trends, socioeconomic trajectories, and alcohol consumption patterns in the region. For example, in 2011, the life expectancies at age 45 years in Russia, Poland, Czech Republic and the European Union were 28.6, 33.1, 34.0 and 36.4 respectively (WHO, 2011). In general, CEE countries have better health outcomes than FSU countries. Due to this heterogeneity, the operationalization of CASP and some items are likely to have different cultural meaning or value for those from CEE and FSU.

6.2.4 Key predictors of CASP in HAPIEE

To establish the determinants of quality of life amongst older adults living in CCEE, this project investigated the effects of socio-demographic, behavioural risk factors, physical and mental health, and social relationship variables on quality of life, using the validated version of CASP for HAPIEE population (CASP12v3).

The results of this thesis provided support for most of the hypotheses regarding predictors of CASP in HAPIEE (**Hypotheses 4.1 to 4.5**), showing that impaired

quality of life is associated with symptoms of depression, poor physical health, especially poor self-rating of health, and material deprivation. Furthermore, age, gender, marital status, better education and higher household amenities score were also confirmed as significantly associated with CASP12v3 score in these groups of older adults. Higher physical functioning score and greater frequency of contact with friends and relatives significantly improved quality of life. The impact of engaging in physical activity on quality of life was small. All comparisons showed differences in the expected directions and were mostly statistically significant.

Age is a commonly identified determinant of quality of life and CASP. According to unadjusted regression analyses, there was a significant curvilinear relationship between CASP12v3 score and age in Poland and Russia. A negative relationship with age was found in the Czech data. However, age was not an independent predictor of quality of life in the Czech Republic and Poland because its effects became non-significant after controlling for other covariates in the multivariable model. In the multivariable model, significant curvilinear relationship between age and quality of life was seen only among Russian women. Accordingly, one would see an improvement in quality of life from 50 to 60 years and CASP12v3 scores would start to decline thereafter. The legal retirement age in Russia is 60 years for men and 55 for women. Hence, the age curve coincides with the concept of Third Age. The age curve found in Russia suggests that Third Age is also present in Russia and this could be the period with high quality of life among older adults. These findings are in agreement with previous studies of CASP-19 by Netuveli et al (2006), who found that, among English older adults, CASP-19 increases from 50 years to peak at 68 years. From there it gradually started to decline, reaching the same level as at 50 years by 86 years. Similarly, in a cohort of 6,910 older

adults aged 50 and older from wave 1 of the TILDA study, Layte et al (2013) found that quality of life is curvilinear with age. CASP-19 was positive from age 50 but became negative after age 67.

In the multivariable linear regression analyses for the whole sample controlling for sex and other risk factors (results not shown), female gender was associated with higher CASP12v3 scores confirming the findings of earlier studies showing either non-significant or small gender differences in CASP-19 (Wiggins et al., 2004, Netuveli et al., 2006, Layte et al., 2013). These previous studies also showed that women have higher levels of quality of life.

Consistent with the results reported in previous studies, it was found that physical health, measured by different variables, is a very important predictor of quality of life in both men and women. Participants' self-ratings of health appeared to be more important for quality of life than the presence of long-standing illness. Depressive symptoms were also found to have strong negative effects on quality of life; elderly persons with depressive symptoms had significantly worse quality of life (between 2- to 4-points lower CASP12v3 scores) compared with those without depressive symptoms.

Material deprivation was identified as the strongest predictor for CASP12v3 scores among indicators of socioeconomic position across all samples. The impact of material deprivation on quality of life was, in general, stronger for men than women. The difference between men and women for the relationship between CASP12v3 scores and material deprivation might be attributed to the

fact that men are often responsible for families' material circumstances. In the Czech Republic, among the SEP variables studied material deprivation was the only significant independent predictor of quality of life in old age. For Russia and Poland CASP12v3 scores increased with household amenities and better education and decreased with material deprivation. The association with education was not statistically significant among men. The reason for this gender difference is unclear. Perhaps, among men the current socio-economic circumstances are more important for quality of life than educational attainment, which may reflect early life achievements. This is in line with the findings of previous study by Blane et al (2004) finding that CASP-19 is primarily influenced by proximal indicators of current material circumstances (e.g receipt of welfare benefits, housing tenure) and CASP-19 scores were not related to past social class characteristics (such as Father's social class) (Blane et al., 2004).

Previous studies have reported that behavioural risk factors such as physical activity and BMI are all associated with CASP-19 scores (Blane et al., 2008, Wu et al., 2014). In contrast to the findings of earlier studies, there was no statistically significant independent effect of BMI on CASP12v3 scores in Russia and the Czech Republic. The magnitude of the association between physical activity and quality of life was small.

In the HAPIEE study, social relationship variables were statistically significant predictors of quality of life amongst older adults. Among Czech and Russian older adults, it was the frequency of meetings with friends that was important determinant of quality of life, with those meeting their friends more often having

higher CASP12v3 scores, while it was frequency of contact with family that was indicative of higher quality of life among Polish women. In agreement with findings of the present study, several studies reported similar association between relationship with family and friends and CASP (Wiggins et al., 2004, Netuveli et al., 2006, Webb et al., 2010, Shankar et al., 2014). Shankar et al (2014), for example, have shown that social isolation and loneliness are associated with poorer hedonic well-being, measured using the 4-item pleasure subscale of CASP, at baseline and over 6 years amongst older adults in ELSA.

In the dataset studied, frequency of contact with family had a significant association with CASP12v3 score among the sample of Polish older adults, while relationship with friend was related to quality of life in the Czech data. The differences in findings across the cohorts may be attributed to the difference in socio-cultural characteristic of the countries. Czech Republic and Russia are countries which are characterized by high levels of secularisation. In these countries, people tend to place less emphasis on traditional family values and value non-family ties, such as friends as important (Inglehart and Baker, 2000, Inglehart and Welzel, 2005, Phellas, 2013). In comparison, the level of commitment to Catholicism is high in Poland and people hold traditional attitudes about family roles in general. This is further supported by the SHARE data which indicated that older adults from Poland place a stronger cultural emphasis on family ties compared with those in the Czech Republic who tend towards the non-traditional family structure (Börsch-Supan et al., 2008). Hence, cultural variations might explain why frequency of contact with family has a significant association with CASP score among older Polish adults, while frequency of contact with friends was related to CASP score in among Czech participants.

6.3 Implications for policy

Findings from this study hold important implications from epidemiological and public health perspectives. The findings confirmed the predictive use of CASP measure in combination with the well-established risk factors for the assessment of mortality risk for older adults in CCEE. The results of the present study suggest that Interventions targeting quality of life to improve longevity must also address declines in physical health to be effective. This can be achieved through better co-ordination of health and long-term care services and enhanced prevention services to tackle health problems. Findings of this study also provide some evidence of mediating effects through social contacts. Therefore, policies which encourage the maintenance of social relationships in old age may be worth pursuing. Strategies to promote social relationships include community-based interventions such as befriending schemes. It is also important to promote to all age groups the importance of building up social networks throughout life course to ensure that people have a stock of social resources in old age. Also, encouraging older people to participate in social, neighbourhood and communal activities such as in charitable or community organizations may be helpful in maintaining links with family and friends in later life.

Chapter 7

Conclusion

In conclusion, the results of this PhD have confirmed the reliability and validity of CASP12v3 score as a suitable tool in measuring and evaluating quality of life of older adults in three countries of Central and Eastern Europe and former Soviet Union. This PhD contributes to the growing body of evidence on CASP by assessing the predictive power of CASP12v3 score for subsequent mortality within three countries of CCEE/FSU region (Czech Republic, Russia and Poland), which are experiencing rapid social and demographic transition. Low quality of life at baseline in 2002–2005 was associated with an increased risk of mortality at follow-up. After taking account of the effects of age, sex, marital status, socioeconomic status, physical activity, obesity, and symptoms of depression, there was a significant graded relationship between mortality risk and tertiles of quality of life score in each cohort. However, additional adjustment for physical health attenuated the hazard ratios to statistical non-significance. Furthermore, this project also adds to the current knowledge base by demonstrating the underlying causal pathways contributing to this relationship. The inverse association between CASP12v3 score and mortality risk was mediated by physical health and social relationship variable, such that the impact of CASP12v3 score beyond these risk factors was less important. Future research should work on identifying the specific biological pathways through which quality of life affect mortality risk. Also, future studies should employ a longitudinal design in order to investigate the temporal order of causation suggested by the mediation analyses

Appendix 1 Hazard ratios (95% CIs) for all-cause mortality by CASP scores and individual CASP-19 domains among Czech men and women.

Czech Republic	Men		Women	
	Crude (95%CI)	Multivariable model	Crude (95%CI)	Multivariable model
Whole scale (CASP-19)	**0.95 (0.93 to 0.97)**	0.99 (0.96 to 1.01)	**0.95 (0.93 to 0.97)**	**0.97 (0.93 to 0.99)**
Individual domains				
Control	**0.91 (0.85 to 0.96)**	0.99 (0.90 to 1.09)	**0.89 (0.82 to 0.96)**	0.99 (0.87 to 1.12)
Autonomy	**0.89 (0.85 to 0.94)**	1.05 (0.96 to 1.15)	**0.90 (0.84 to 0.96)**	0.97 (0.87 to 1.08)
Pleasure	**0.86 (0.81 to 0.91)**	**0.86 (0.78 to 0.96)**	**0.87 (0.82 to 0.93)**	0.93 (0.83 to 1.04)
Self-realisation	**0.88 (0.84 to 0.93)**	1.04 (0.96 to 1.13)	**0.86 (0.81 to 0.92)**	0.97 (0.86 to 1.09)
CASP12v1	**0.94 (0.91 to 0.96)**	0.99 (0.95 to 1.03)	**0.93 (0.90 to 0.96)**	0.96 (0.91 to 1.01)
CASP12v2	**0.93 (0.91 to 0.95)**	0.98 (0.94 to 1.02)	**0.93 (0.90 to 0.96)**	0.96 (0.91 to 101)
CASP12v3	**0.93 (0.91 o 0.95)**	0.98 (0.94 to 1.01)	**0.92 (0.89 to 0.96)**	0.95 (0.90 to 1.01)

Note: Significant results are highlighted in bold. Crude models are analyses without any adjustments.

Multivariable model included age, age-squared, sex, marital status, education, household amenities score, material deprivation score, occupational status, years in retirement, self-rated health, long-term health problems, physical functioning, depressive symptoms, BMI, physical activity, and frequency of contact with friends, and relatives. Domain-specific analysis mutually adjusted for each of the CASP domain scores.

Appendix 2 Hazard ratios (95% CIs) for all-cause mortality by CASP scores and individual CASP-19 domains among Russian men and women.

Russia	Men		Women	
	Crude (95%CI)	Multivariable model	Crude (95%CI)	Multivariable model
Whole scale (CASP-19)	**0.97 (0.96 to 0.98)**	0.99 (0.98 to 1.01)	**0.96 (0.94 to 0.97)**	0.98 (0.96 to 1.00)
Individual domains				
Control	**0.95 (0.92 to 0.99)**	**1.07 (1.02 to 1.12)**	**0.91 (0.86 to 0.95)**	1.00 (0.94 to 1.07)
Autonomy	**0.90 (0.87 to 0.93)**	0.95 (0.89to 1.00)	**0.90 (0.85 to 0.95)**	0.96 (0.89 to 1.02)
Pleasure	**0.92 (0.89 to 0.95)**	0.98 (0.93 to 1.02)	**0.94 (0.90 to 0.98)**	1.01 (0.96 to 1.07)
Self-realisation	**0.94 (0.91 to 0.96)**	0.99 (0.95 to 1.02)	**0.91 (0.88 to 0.95)**	0.97 (0.92 to 1.01)
CASP12v1	**0.96 (0.94 to 0.98)**	1.00 (0.98 to 1.03)	**0.94 (0.92 to 0.97)**	0.98 (0.96 to 1.01)
CASP12v2	**0.96 (0.94 to 0.97)**	1.00 (0.98 to 1.02)	**0.94 (0.92 to 0.96)**	0.98 (0.96 to 1.01)
CASP12v3	**0.95 (0.94 to 0.97)**	0.99 (0.97 to 1.02)	**0.94 (0.92 to 0.96)**	0.98 (0.95 to 1.00)

Note: Significant results are highlighted in bold. Crude models are analyses without any adjustments.

Multivariable model included age, age-squared, sex, marital status, education, household amenities score, material deprivation score, occupational status, years in retirement, self-rated health, long-term health problems, physical functioning, depressive symptoms, BMI, physical activity, and frequency of contact with friends, and relatives.

Appendix 3 Hazard ratios (95% CIs) for all-cause mortality by CASP scores and individual CASP-19 domains among Polish men and women.

Poland	Men		Women	
	Crude (95%CI)	Multivariable model	Crude (95%CI)	Multivariable model
Whole scale (CASP-19)	**0.97 (0.96 to 0.98)**	1.00 (0.98 to 1.01)	**0.96 (0.95 to 0.97)**	0.99 (0.97 to 1.01)
Individual domains				
Control	**0.89 (0.86 to 0.92)**	**0.94 (0.88 to 0.99)**	**0.86 (0.82 to 0.90)**	0.93 (0.86 to 1.01)
Autonomy	**0.94 (0.91 to 0.97)**	1.04 (0.99 to 1.10)	**0.91 (0.87 to 0.96)**	1.00 (0.93 to 1.09)
Pleasure	**0.95 (0.91 to 0.98)**	1.07 (0.99 to 1.14)	**0.90 (0.86 to 0.95)**	1.01 (0.92 to 1.12)
Self-realisation	**0.91 (0.89 to 0.94)**	0.96 (0.91 to 1.01)	**0.91 (0.88 to 0.95)**	1.02 (0.95 to 1.10)
CASP12v1	**0.96 (0.95 to 0.98)**	1.00 (0.98 to 1.03)	**0.95 (0.93 to 0.97)**	1.00 (0.97 to 1.04)
CASP12v2	**0.96 (0.94 to 0.97)**	0.99 (0.98 to 1.02)	**0.94 (0.92 to 0.96)**	0.98 (0.95 to 1.02)
CASP12v3	**0.95 (0.94 to 0.97)**	0.99 (0.96 to 1.01)	**0.94 (0.91 to 0.96)**	0.99 (0.95 to 1.02)

Note: Significant results are highlighted in bold. Crude models are analyses without any adjustments.

Multivariable model included age, age-squared, sex, marital status, education, household amenities score, material deprivation score, occupational status, years in retirement, self-rated health, long-term health problems, physical functioning, depressive symptoms, BMI, physical activity, and frequency of contact with friends, and relatives. Domain-specific analysis mutually adjusted for each of the CASP domain scores.

Appendix 4 Comparison of sociodemographic, health, and mental health characteristics between complete cases and cases with missing data across CASP-19 items , in HAPIEE study.

	Czech Republic					Poland				
	Missing CASP score (N=817, %)	**Complete cases (N=2,816, %)**	**P-value**	**Odds ratio (odds for non-response)**	**95% CI**	**Missing CASP score (N=350)**	**Complete cases (N=5,307, %)**	**P-value**	**Odds ratio**	**95% CI**
Sex			**<0.001**					0.90		
Male	34.2	41.6		1		46.3	45.9		1	
Female	65.8	58.4		1.37	1.17 to 1.62	54.1	53.7		0.99	0.79 to 1.22
Age (Mean, SD)	65.4	64.2	0.23			62.3	62.2	0.70		
Education level			**<0.001**					0.20		
Primary	23.5	15.5		1		14.6	16.8		1	
Vocational	38.2	37.1		0.68	0.55 to 0.84	21.7	23.1		1.08	0.75 to 1.56
Secondary	28.5	35.8		0.53	0.42 to 0.66	38.9	40.2		1.11	0.80 to 1.55
University	8.3	11.1		0.50	0.37 to 0.68	24.3	19.8		1.41	0.99 to 2.02
Missing	1.5	0.5				0.5	0.1			
Household amenities score (0-12), mean (SD)			**<0.001**					0.77		
Bottom tertile (low amenities)	40.8	31.6		1		35.1	34.1		1	
Middle tertile	38.8	39.5		0.76	0.64 to 0.91	42.6	41.9		0.99	0.77 to 1.26
Top tertile (high amenities)	20.4	28.9		0.55	0.45 to 0.68	22.3	24.0		0.90	0.67 to 1.21

Appendix 4. (continued)	Czech Republic					Poland				
	Missing CASP score (N=817, %)	Complete cases (N=2,816, %)	P-value	Odds ratio (odds for non-response)	95% CI	Missing CASP score (N=350)	Complete cases (N=5,307, %)	P-value	Odds ratio	95% CI
Material deprivation score			**0.05**					**0.001**		
Low (0)	67.3	71.7		1		57.4	60.7		1	
Medium (1-6)	31.6	27.5		1.23	1.03 to 1.45	36.6	36.8		1.04	0.84 to 1.32
High (7-9)	1.1	0.8		1.38	0.64 to 2.80	6.0	2.5		2.49	1.54 to 4.03
Marital status			**0.05**					**0.08**		
Married or cohabiting	71.0	74.7		1		74.6	72.4		1	
Single	2.5	1.6		1.58	0.93 to 2.69	6.8	4.6		1.45	0.94 to 2.24
Divorced	8.6	9.2		0.98	0.74 to 1.30	6.6	6.9		0.92	0.59 to 1.43
Widowed	17.3	14.4		1.27	1.03 to 1.58	12.0	15.9		0.74	0.53 to 1.03
Missing	0.6	0.1				0.0	0.2			
Health status			**0.008**					0.47		
Very good and good	27.8	33.4		1		23.4	22.7		1	
Average	57.9	55.7		1.25	1.05 to 1.49	53.4	57.0		0.91	0.69 to 1.19
Poor and very poor	12.7	10.5		1.46	1.12 to 1.91	22.3	20.2		1.07	0.78 to 1.47
Missing	1.6	0.4				0.9	0.1			

Appendix 4 (Continued)	Czech Republic					Poland				
	Missing CASP score (N=817, %)	Complete cases (N=2,816, %)	P-value	Odds ratio (odds for non-response)	95% CI	Missing CASP score (N=350)	Complete cases (N=5,307, %)	P-value	Odds ratio	95% CI
Depressive symptoms (CES-D 20)			**<0.001**					**0.05**		
No	62.7	78.0		1		59.7	70.1		1	
Yes	17.0	16.8		1.26	1.02 to 1.55	30.6	28.4		1.26	0.99 to 1.61
Missing	20.3	5.2				9.7	1.5			
Smoking			**0.05**					0.79		
Never	51.2	48.4		1		42.9	43.3		1	
Past	26.1	31.1		0.79	0.66 to 0.96	28.9	30.0		0.97	0.75 to 1.26
Currently	18.7	20.0		0.89	0.72 to 1.10	28.0	26.4		1.07	0.83 to 1.40
Missing	4.0	0.5				0.2	0.3			
BMI (mean)	28.9	29.0	0.62			28.5	28.8	0.28		
Frequency of contact with relatives			0.22					0.23		
No relatives	1.5	1.0		1		6.6	4.6		1	
Less than once a month	8.2	8.8		0.63	0.30 to 1.31	29.1	27.2		0.75	0.47 to 1.20
Once a month or more	27.9	25.4		0.75	0.37 to 1.49	32.9	35.3		0.65	0.41 to 1.03
Once a week or more	60.2	64.0		0.64	0.32 to 1.26	30.6	32.7		0.65	0.41 to 1.04
Missing	2.2	0.8				0.8	0.2			

Appendix 4 (Continued)	Czech Republic					Poland				
	Missing CASP score (N=817, %)	Complete cases (N=2,816, %)	P-value	Odds ratio (odds for non-response)	95% CI	Missing CASP score (N=350)	Complete cases (N=5,307, %)	P-value	Odds ratio	95% CI
Frequency of contact with friends			0.17					0.14		
No friends	4.3	2.8		1		8	8.7		1	
Less than once a month	20.1	20.7		0.64	0.41 to 0.98	33.1	30.4		1.19	0.78 to 1.82
Once a week or more	31.8	33.2		0.63	0.41 to 0.96	24.9	22.4		1.21	0.78 to 1.88
Missing	2.4	0.6				2.6	0.7			
Mean CASP12v3 score	8.8	23.2	**<0.001**		0.66 to 0.96	18	24.2	**<0.001**		
Mortality	13.6	10.9	**0.02**		0.72 to 1.10	12	11	0.54		

-Differences between groups were assessed using the Student's t-test or chi-square test.

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