Xu Feifei: Socioeconomic Determinants of Health-Related Quality of Life and Life Satisfaction During COVID-19 Pandemic in Hungary

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Socioeconomic Determinants of Health-Related Quality of Life and Life Satisfaction During COVID-19 Pandemic in Hungary

DOCTORAL DISSERTATION

Supervisor: Prof. Valentin Brodszky

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Doctoral School of Economics, Business, and Informatics in partial fulfillment of the
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Supervisor: Prof. Valentin Brodszky

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List of Abbreviations

Cost-Benefit Analysis	CBA
Cost-Effectiveness Analysis	CEA
Cost-Utility Analysis	CUA
Cost-Consequence Analysis	CCA
Distributional Cost-Effectiveness Analysis	DCEA
EuroQol-5 Dimension	EQ-5D
Health-Related Quality of Life	HRQoL
Preferred Reporting Items for Systematic Reviews and Meta-Analyses	PRISMA
Quality of Life	QoL
Satisfaction with Life Scale	SWLS
Statistical Product and Service Solutions	SPSS
Subjective Well-being	SWB
Standard Game	SG
The Patient Health Questionnaire	PHQ-9
The General Anxiety Disorder Assessment	GAD-7
Time Trade-Off	TTO
Visual Analog Scale	VAS
World Health Organization	WHO
36-item Short-Form Health Survey	SF-36

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1 Introduction

The COVID-19 pandemic, marked by the emergence of the SARS-CoV-2 virus, created a global public health crisis, prompting the World Health Organization (WHO) to declare it a global pandemic in March 2020 (WHO, 2020, March 11). By the end of 2023, over 772 million confirmed COVID-19 cases and nearly seven million deaths were reported globally, illustrating the virus's profound impact (WHO, 2023). Governments worldwide, including Hungary's, implemented measures to curb COVID-19 spread and manage its impact. Actions included border shutdowns, travel restrictions, and closures of schools, workplaces, public transport systems, and non-essential businesses. Social distancing and quarantine protocols were also widely enforced (Ufficiale, Organization, 2020a, Trade, 2020). This unprecedented situation has led to a complex array of symptoms and long-term health problems across various demographic groups, and has also magnified global inequalities impacting the physical, mental, social, and subjective well-being of individuals (Annette, 2021). Therefore, this dissertation focuses on the critical need for comprehensive analyses of its impact on Health-Related Quality of Life (HRQoL) and Subjective Well-Being (SWB), particularly through the lens of socioeconomic determinants and COVID-19-related characteristics in Hungary.

The COVID-19 has manifested a wide range of symptoms adversely affecting multiple organs, leading to long-term health complications (Kakodkar *et al.*, 2020). Specific impacts include damage to the heart (leading to myocardial and heart failure) and lungs (causing damage to lung tissue and restrictive lung failure). These severe physical health impacts significantly diminish individuals' ability to perform daily activities and maintain independence, directly lowering their HRQoL. Neurological manifestations such as anosmia and cognitive impairments disrupt personal and professional activities and contribute to social isolation and decreased life satisfaction. Thus, psychological effects, including anxiety, depression, and sleep disturbances (Leung *et al.*, 2020), exacerbating the strain on mental health and leading to an overall decline in subjective well-being. Additionally, even after recovery, patients may continue to struggle with hypoxia, shortness of breath, and reduced work capacity (Bryson, 2021, Santus *et al.*, 2020, Leung *et al.*, 2020). These prolonged health issues necessitate sustained medical care and ongoing psychological stress, severely impairing HRQoL and contributing to long-term reductions in life satisfaction.

Beyond health impacts, the pandemic has had varied effects on HRQoL and life satisfaction. Some have benefited from changes such as improved work-life balance due to remote working arrangements (Kowalski and Ślebarska, 2022) and decreased pollution levels (Wang and Ge, 2023). Furthermore, the pandemic has increased public awareness of health, encouraging some individuals to adopt healthier lifestyles, such as increased physical activity, better hygiene practices, and healthier eating habits (Delgado-Ortiz *et al.*, 2023). However, the unpredictable nature of the COVID-19 pandemic and the lack of reliable information have led to a subtle but significant deterioration in HRQoL and SWB (Coelho *et al.*, 2020). Studies reveal a marked increase in these conditions compared to pre-pandemic levels (Bäuerle *et al.*, 2020, Benke *et al.*, 2020, Bendau *et al.*, 2021, Jané-Llopis *et al.*, 2021), with women (Abreu *et al.*, 2021, Benke *et al.*, 2020, Ellwardt and Präg, 2021, Ferreira *et al.*, 2021b, Teotônio *et al.*, 2020), younger individuals (Benke *et al.*, 2020, Ferreira *et al.*, 2021b, Teotônio *et al.*, 2020), those experiencing financial strain (Gadermann *et al.*, 2021, Feter *et al.*, 2021), the unemployed (Teotônio *et al.*, 2020, Benke *et al.*, 2020), and those with pre-existing conditions (Dawel *et al.*, 2020, Ellwardt and Präg, 2021, Ferreira *et al.*, 2021b) being particularly vulnerable.

Social isolation, a key intervention to curb the virus's spread, has been profound. Despite its effectiveness in reducing the spread of the virus, practices such as social distancing and self-isolation have heightened loneliness and psychological distress, disrupted normal daily routines, and reduced access to medical care (Garfin *et al.*, 2020). The tragic case of a 50-year-old man and father of three who, on February 12, 2020, isolated himself after suspected COVID-19 infection and ultimately took his own life, underscores the dire impact of pandemic-related isolation and misinformation (Goyal *et al.*, 2020). Importantly, empirical studies of previous infectious disease outbreaks (e.g., SARS, H1N1) describe adverse psychological effects such as depression, anxiety, insomnia, and post-traumatic stress symptoms during periods of quarantine (Hawryluck *et al.*, 2004, Mihashi *et al.*, 2009, DiGiovanni *et al.*, 2004, Jeong *et al.*, 2016, Lee *et al.*, 2005, Lee *et al.*, 2006, Reynolds *et al.*, 2008, Brooks *et al.*, 2020). Even in the absence of viral infection, social isolation exerts profound effects on neurobiological, endocrine, and genetic mechanisms associated with mood disorders, sleep disturbance, neurocognitive decline, impaired immune function, and increased vulnerability to threat (Cacioppo and Hawkley, 2009).

The research emphasizes the broader effects of the pandemic on HRQoL, emphasizing the importance of health technology assessment (HTA) and economic evaluations such as cost-utility analysis (CUA). The EQ-5D, a preferred instrument in HTA, helps calculate quality-adjusted life years (QALYs) by measuring health states on a scale from 0 (equivalent to death) to 1 (perfect health), facilitating a comprehensive economic evaluation of healthcare interventions' cost-effectiveness. This structured approach in evaluating HRQoL during COVID-19, using standardized and validated instruments, is critical for informing public health policies and intervention strategies to mitigate the pandemic's impact (Richardson, 1994, Kennedy-Martin *et al.*, 2020).

The research highlights the significant public health implications of psychological and well-being issues during the pandemic. Research underscores the pivotal role of higher life satisfaction in bolstering psychological health and well-being, highlighting the interplay between socio-demographics, psychological traits, lifestyle choices, and leisure activities (Mehrsafar *et al.*, 2021, Passos *et al.*, 2020, Rogowska *et al.*, 2021, Xiao *et al.*, 2021). Given this backdrop, understanding individuals' SWB throughout the pandemic becomes paramount. The SWLS serves as a foundational tool in this endeavor, offering insights into general well-being by assessing individuals' satisfaction with life (Diener *et al.*, 1985). Beyond general life satisfaction, targeted screening for symptoms of depression and anxiety is crucial, given their prevalence during such tumultuous times. The Patient Health Questionnaire (PHQ-9) and the General Anxiety Disorder Assessment (GAD-7) are instrumental in this regard. The PHQ-9, through its nine-item questionnaire, gauges the severity of depression by exploring experiences of depressed mood and anhedonia over the previous two weeks (Choo *et al.*, 2001). Similarly, the GAD-7, with its seven questions, delves into the core symptoms of generalized anxiety disorder, such as persistent nervousness and uncontrollable worrying (Spitzer *et al.*, 2006). By contextualizing these tools within the pandemic's unique challenges, we can gain a more nuanced understanding of its impact on mental health. This approach not only clarifies the direct linkages between life satisfaction and psychological well-being but also emphasizes the necessity of adopting comprehensive strategies to address the mental health crisis exacerbated by COVID-19.

This research aims to fill the gap in understanding how specific sociodemographic, socioeconomic, and COVID-19-related characteristics have influenced HRQoL and

SWB during the pandemic, particularly in Hungary. By investigating these factors, this study seeks to develop targeted interventions and policies to support affected populations and mitigate long-term adverse outcomes. In Hungary, the government took proactive measures to manage the pandemic, including declaring a nationwide lockdown several times (Hungary, 2020, Köves, 2021). Even when the quarantine was partially lifted, social distancing protocols (maintaining a distance of one and a half meters) remained in place, and the mandatory use of masks while shopping and on public transport continued. During the lockdown periods, the resumption of indoor service in restaurants, cafes, bakeries, and buffets was sanctioned. These measures may have seriously affected general Hungarians' HRQoL and SWB. Thus, this research aimed to investigate socioeconomic determinants of HRQoL and life satisfaction within a Hungarian population-representative sample during the COVID-19 pandemic in the fall of 2021, and to identify specific factors affecting HRQoL and life satisfaction. Furthermore, we aimed to investigate risk and protective factors in a high-risk group for life satisfaction.

In summary, this dissertation provides an in-depth exploration of the impact of the COVID-19 pandemic on HRQoL and life satisfaction, with a particular focus on Hungary. Chapter 2 sets the context by exploring the global impact of COVID-19 and the critical role of economic evaluation and HRQoL in healthcare decision-making. It links health outcomes with economic evaluation and provides a comprehensive background. Chapter 3 presents a literature review on HRQoL and life satisfaction during the pandemic, highlighting the global impact on well-being and disparities between different groups. Chapter 4, the core of the thesis, details the empirical research on HRQoL in Hungary during the pandemic, outlining data collection, methodology, analysis, results, and comparisons. It reveals the nuanced effects of the pandemic on the Hungarian population's well-being through rigorous empirical investigation. Overall, the study carefully combines theoretical frameworks with empirical evidence to assess the broad and localized impact of the pandemic on quality of life.

2 Background

The background chapter explores the multifaceted impact of the COVID-19 pandemic, the principles of economic evaluation in healthcare, and the nuances of quality of life (QoL) assessments in depth. It begins with the emergence of COVID-19, detailing its global spread and various containment measures implemented worldwide. The discussion then moves to economic evaluations, highlighting their importance in healthcare decision-making and introducing key methodologies such as cost-benefit analysis and cost-utility analysis. Particular attention is given to the normative principles underpinning these evaluations, contrasting welfarist and extra-welfarist approaches. Finally, the chapter examines the concepts of QoL, HRQoL, subjective well-being, and life satisfaction, highlighting their evolution, theoretical underpinnings and importances for improving patient-centered care.

2.1 The COVID-19 Pandemic

The initial outbreak of the novel coronavirus, known as COVID-19, quickly spread to Europe, where the first confirmed case occurred in France on 24 January 2020 (Bernard Stoecklin *et al.*, 2020, Deslandes *et al.*, 2020). Germany reported its first infection in Bavaria on 27 January, leading to a local outbreak. By 19 February, 16 cases had been confirmed, with 241 high-risk contacts had been identified through contact tracing (Bohmer *et al.*, 2020). As previously mentioned in Section 1 (p. 9), the pandemic emerged globally in early 2020, with Hungary implementing significant measures such as lockdowns, which directly impacted HRQoL (Organization, 2020b).

2.2 Background of Economics Evaluations

Economic evaluation systematically compares alternative health care interventions by considering their respective costs and benefits, as explained by Drummond et al. (Drummond *et al.*, 2015). This concept includes two fundamental dimensions: first, examining the resources invested (costs) and the outcomes achieved (consequences/benefits) by a particular health care interventions, and its connection to the decision-making process. Given limited resources, it is crucial to make informed decisions about health care interventions, recognizing the potential trade-offs in achieving desired outcomes. The core objective of economic evaluation is to support decision-making by providing assessments and comparisons of potential scenarios. Therefore, it is crucial to establish the theoretical principles underlying these evaluations, based on shared assumptions about value definitions (Drummond *et al.*, 2015). In health economics, practitioners synthesize normative and positive economic

theories from the broader field of economics (Morris *et al.*, 2012). Positive economics uses theories to predict social phenomena objectively, while normative economics is rooted in value judgments and guides resource allocation (Ng, 2004). Historically, health economics has primarily focused on normative analysis, particularly through economic evaluation, which addressed questions of resource allocation for specific healthcare interventions.

Economic evaluation critically examines the analytical techniques used, often determined by the underlying theoretical framework guiding the analysis. While there is no universally correct choice of technique, a well-reasoned choice based on methodological and theoretical considerations is required. Analysts and decision-makers must thoroughly understand the value assumptions and potential limitations in the analytical results, as the diverse normative principles and analytical techniques can lead to divergent resource allocations and recommendations (Buchanan and Wordsworth, 2015). Consequently, a comprehensive understanding of the underlying value assumptions and selected analytical methods is economic valuation is paramount. Recent advances have introduced numerous methodological and analytical approaches to evaluating health care interventions, particularly in cost-benefit analysis (CBA), cost-effectiveness analysis (CEA), distributional cost-effectiveness analysis (DCEA), cost-utility analysis (CUA), cost-minimization analysis (CMA), and cost-consequence analysis (CCA) (Drummond *et al.*, 2015, McIntosh and Li, 2012).

2.2.1 Introduction to the Economic Evaluation of Health Care Interventions

In recent years, economic evaluation has gained prominence for guiding decision makers in choosing between different programs or interventions (Brouwer and Koopmanschap, 2000). The process of determining which option offers better value for money, considering both benefits and costs, inherently contains explicit or implicit prescriptive elements. Although economists may appear to advocate for or against certain options, most emphasize their role in providing evidence to inform decisions rather than making them. Limiting the economist's role to describing the benefits and costs of alternative does not eliminate value judgments. Economic evaluation emphasizes the measurement and valuation of benefits, with costs defined as the value of foregone alternative opportunities. Increasing the well-being of one individual or group at the expense of others prompts deliberation about the desirability of an option, invoking value judgments about such trade-offs. Much of the theoretical discourse on the foundations of economic evaluation revolves around variations in methodologies

for the normative analysis of health and health care, mainly related to distinctions between ‘welfarist’ and ‘extra-welfarist’ approaches (Brouwer *et al.*, 2008).

2.2.2 Normative Principles

Normative economics is often conflated with welfare economics in the mainstream economics literature, as shown by scholars like Boadway and Bruce et al. (Ng, 2004) and Johansson et al. (Johannesson and Jönsson, 1991). Sen introduced the term ‘welfarist’ (Sen, 1977) to distinguish the traditional normative economic approach to social choice from contemporary and critical non-welfarist perspectives. The normative basis for economic evaluation aligns with the extra-welfarist framework described by Brouwer and Koopmanschap et al. (Brouwer and Koopmanschap, 2000). Applying a welfarist perspective in economic evaluation requires including all costs and benefits, as emphasized by Brouwer and colleagues. Conversely, the extra-welfarist framework focuses primarily on optimizing health outcomes within a given budget.

2.2.2.1 Welfarist Foundations of Economic Evaluation

Welfare economics is a framework that analyzes resource allocation and individual utility, assuming rational agents act in their best interest to maximize welfare, focusing on outcomes over processes.(Drummond *et al.*, 2015, Morris *et al.*, 2012, Brouwer *et al.*, 2008). Hurley et al. summarizes the core principles of welfarist economics as utility maximization, individual sovereignty, consequentialism, and welfarism (Hurley, 2000). It emphasizes utility maximization, individual sovereignty, and consequentialism. Welfarism evaluates desirability based solely on utility. The theory is rooted in Paretian welfare economics, which suggests optimal resource allocation occurs when one person’s well-being improves without making others worse off (Cookson *et al.*, 2012, Hurley, 2000). However, this is often impractical, leading to the compensation principle, which suggests societal welfare improves if those who benefit from a policy could compensate those who lose out, even if this compensation is theoretical (Kattan and Cowen, 2009). Economic evaluations often use cost-benefit analysis (CBA) rooted in welfare theory, though equity concerns arise due to the challenges of monetizing health and valuing outcomes across different individuals (McIntosh, 2010).

2.2.2.1.1 Allocation of Scarce Resources to Maximize Social Welfare

Welfarist economics seeks to allocate resources optimally to maximize societal welfare (Kattan and Cowen, 2009). Traditional welfarist frameworks used cardinal utility (comparable across individuals), (Brouwer *et al.*, 2008, Hurley, 2000, Kattan and Cowen, 2009). but modern economics has shifted to ordinal utilities, focusing on whether utility increases or decreases without comparing the magnitude of change across individuals (Brouwer *et al.*, 2008, Kattan and Cowen, 2009).

2.2.2.1.2 Pareto and Improvement Pareto Principles

The Pareto principle states that a situation is preferred if at least one individual's utility improves without harming others (Brouwer *et al.*, 2008, Tsuchiya and Williams, 2001). The potential Pareto criterion allows for compensation between gainers and losers to determine whether a situation is an improvement, assuming that compensation could be made (Tsuchiya and Williams, 2001). In real-world markets, "shadow prices" may be used when market distortions prevent accurate valuation (Claxton *et al.*, 2007).

2.2.2.1.3 Welfarist Foundation of Health Economic Evaluation

The concepts and framework of welfare economics apply to healthcare. However, terminology inconsistencies exist in literature. To avoid confusion, this paper uses the term 'welfarist approach' to describe the health economic evaluation method based on welfarist concepts. According to Hurley (Hurley, 2000), the main characteristic of the welfarist approach (unlike the extra-welfarist approach in Chapter 2.2.2.2) is the use of utility to assess value. In healthcare, the welfarist approach uses utility to assess value, with willingness to pay (WTP) often serving as a proxy for utility changes. However, WTP can be influenced by income distribution, which affects the ability to pay. Issues arise when compensation is used to value health, especially when life loss is involved, as compensation may not be appropriate in these cases. (Claxton *et al.*, 2007, Drummond *et al.*, 2015). Additionally, the welfarist approach limits the evaluation to individual utilities, bypassing the need for external equity judgments, which can only be incorporated if individuals' utility measures reflect equity concerns (Broome, 1978, Brouwer *et al.*, 2008, Claxton *et al.*, 2007).

2.2.2.2 Extra-welfarist Foundation of Economic Evaluation

2.2.2.2.1 The Origins of the Extra-welfarist Foundation

Given the limitations of the welfarist approach in the health care, the extra-welfarist approach has gained popularity (Drummond *et al.*, 2015). In extra-welfarist framework recognizes factors beyond individual outcomes, expanding the valuation source beyond the individual (Brazier *et al.*, 2017). Authoritative decision-makers, experts, public representatives, or affected individuals can define the valuation space, including the elements to include or exclude (Brouwer *et al.*, 2008).

In health care, extra-welfarism expands the evaluation space to include health, aiming to maximize health outcomes within a given budget (Brouwer *et al.*, 2008, Culyer, 1989). Health gains are often measured in quality-adjusted life years (QALYs) (Drummond *et al.*, 2015). Resource allocation prioritizes interventions yielding the highest health gains relative to incremental costs (Hauck *et al.*, 2004). However, this health focus in practice has led some to question whether extra-welfarism offers more than traditional welfarism (Birch and Donaldson, 2003). The extra-welfarist approach is also known as the 'non-welfarist' approach (Culyer, 1989, Drummond *et al.*, 2015). This term emphasizes that this approach uses a different valuation space ('extraordinary' rather than 'extra'), not just expanding individuals' utility. Utility-based information can be replaced by other characteristics or capabilities, or supplemented with data on utility quality or equity considerations (Brouwer *et al.*, 2008). The extra-welfarist approach shifts the outcome of interest from utility-based welfare to a broader 'well-being' (Brouwer *et al.*, 2008). Essentially, 'welfare' refers to well-being assessed by utility, while 'well-being' is a broader concept assessed by other terms (Hurley, 2000).

2.2.2.2.2 Current Implementation of the Extra-welfarist Principles

The uniqueness of health in economic literature has led to evaluations focusing on health rather than welfare (Drummond *et al.*, 2015). Under the modern interpretation of extra-welfarist principles, policymakers pursue health for its intrinsic value, regardless of its utility (Brouwer *et al.*, 2008). Thus, maximizing health gains becomes the primary goal of health programs, constrained by a single exogenous budget determined by available health resources (Coast *et al.*, 2008b). However, the extra-welfarist approach requires formulating a social objective function to be maximized. When an intervention's primary goal is health, excluding other factors from the social objective function is reasonable (Sculpher and Claxton, 2012).

The interpretation and implementation of the extra-welfarist approach in health care economic evaluation remain debated (Coast *et al.*, 2008b). Health is measured in length and quality of life, often using quality-adjusted life years (QALYs) with equal valuation across the population (Drummond *et al.*, 2015). For example, the recommendations of the National Institute for Health and Care Excellence (NICE) have established the widespread extra-welfare practice of using QALYs as the standard measure of value (Coast *et al.*, 2008b). Coast et al. (Coast *et al.*, 2008b) note that Sen's capability approach initially had a broader perspective, emphasizing equity and distributional concerns. Moreover, the implicit assumption that social welfare depends solely on health maximization has been criticized.

The focus on maximization, albeit of health rather than utility, remains related to the welfarist approach (Coast *et al.*, 2008b). Evidence suggests maximizing health utility is not the only concern of society and health care decision-makers. Policymakers and health professionals also consider factors like disease severity, target age, and the magnitude of individual health benefits from interventions (Baji *et al.*, 2016). Birch and Donaldson (Birch and Donaldson, 2003) argue that the extra-welfarist approach recognizes and accepts the risks of paternalism and dictatorial decisions when policymakers impose preferences on individuals. They claim that in Sen's theory (Sen, 1977), the source of valuation still comes from the individual, based on their set of functions and capabilities. Moreover, they claim welfarist economics could theoretically integrate all concerns raised by extra-welfarist proponents by adapting the concept of utility (Birch and Donaldson, 2003). However, the feasibility of these adaptations, such as incorporating equity considerations and valuing intangible social goods within a welfarist context analyzing individual utilities, remains unaddressed. Furthermore, Broome's (Broome, 1978) argument about compensating for risks rather than health remains unresolved.

2.2.3 Analytical Types of Economic Evaluations

Economic evaluation compares the costs and benefits of alternative interventions to inform healthcare decisions (Drummond *et al.*, 2015). It helps assess the economic impact of medical interventions, especially with rising healthcare costs and limited resources (Economic and Development, 2023). Full economic evaluations compare both costs and outcomes of interventions, with key types being cost-benefit analysis (CBA), cost-effectiveness analysis (CEA), cost-utility analysis (CUA), and cost-minimization analysis (CMA). Partial evaluations focus only on costs or outcomes

independently. These evaluations, particularly CEA and CUA, often use quality-adjusted life years (QALYs) to measure outcomes. CMA is used when interventions have similar outcomes but different costs (Drummond *et al.*, 2015, Briggs and O'Brien, 2001).

2.2.3.1 Cost-Benefit Analyses

Cost-benefit analysis (CBA) is an economic evaluation method that assigns monetary values to societal costs and benefits to assess the desirability of specific goals. It allows comparisons across different economic sectors and calculates net social benefit, which is the difference between the program's benefits and costs (McIntosh, 2010, Donaldson, 1998, Gafni, 2006, Grosse *et al.*, 2008, Dolan and Edlin, 2002). Positive net social benefit indicates the program is worthwhile, while negative suggests the opposite (Gafni, 2006). CBA uses methods like the human capital approach, which values increased workforce productivity, and the willingness-to-pay (WTP) approach, which estimates how much individuals are willing to pay for intervention benefits. Despite its advantages, CBA faces challenges, including ethical concerns about valuing life and quality, as well as the complexity of data collection, limiting its application in healthcare compared to cost-effectiveness and cost-utility analyses (Drummond *et al.*, 2015, Cookson, 2005).

2.2.3.2 Cost-Effectiveness Analysis

Cost-effectiveness analysis (CEA) is a popular method for evaluating healthcare programs, especially in countries like the UK (Drummond *et al.*, 2015). It calculates costs and measures health benefits in natural units (e.g., life years gained) (French and Drummond, 2005). Interventions are compared based on cost per unit of effectiveness, guiding resource allocation within budget constraints (Morris *et al.*, 2012). CEA avoids monetizing health, using incremental cost-effectiveness ratios (ICERs) to guide decisions (Brazier *et al.*, 2017). It focuses on maximizing health outcomes rather than utility, often using Quality-Adjusted Life Years (QALYs) as a standard measure (Drummond *et al.*, 2015). While CEA is effective for comparing interventions, it has limitations, especially when interventions have different outcomes. It primarily addresses technical efficiency and is less suited for allocative efficiency across diverse outcomes (French and Drummond, 2005).

2.2.3.3 Distributional Cost-Effectiveness Analysis

Distributional cost-effectiveness analysis (DCEA) integrates equity considerations into cost-effectiveness analysis (CEA). DCEA operates outside the welfare context, focusing on health intervention impacts on health distribution. Essentially, it follows the traditional CEA process of estimating cost and outcome changes due to a new intervention. However, DCEA assesses the distribution of costs and outcomes across different population groups before and after introducing the new intervention. Thus, DCEA distinguishes between groups that benefit from the intervention and those that may experience negative consequences (Ward *et al.*, 2022). The primary purpose of DCEA is to estimate the net impact of an intervention on overall health and specific population groups. It also examines trade-offs between improving overall health and reducing health inequities (Yang *et al.*, 2020). DCEA involves two steps: (1) modeling the social distribution of health for each intervention and (2) evaluating these distributions. DCEA provides insight into the fairness of cost and benefit distribution, showing who may gain, who may lose, and the magnitude of these changes (Asaria *et al.*, 2015, Asaria *et al.*, 2016).

2.2.3.4 Cost-Utility Analyses

Research efforts to develop measures better suited to allocative efficiency have led to a variant of CEA known as cost-utility analysis (CUA). CUA is an economic evaluation where health outcomes are represented by a single, generic measure (Sassi, 2006, Edwards *et al.*, 2013, Bilinski *et al.*, 2017). This approach uses a non-welfarist framework where health benefits are expressed as quality-adjusted life years (QALYs) (French and Drummond, 2005).

The primary goal of CUA is to capture changes in HRQoL by integrating morbidity and mortality effects into a single measure (Drummond *et al.*, 2015, Gray *et al.*, 2010). This process begins with measuring or 'describing' health status using generic, multi-attribute measures that cover a broad range of health dimensions and quality of life, rather than specific health problem effects (Brazier *et al.*, 2017, Drummond *et al.*, 2015). For example, widely used systems like the EuroQol Five Dimensions Questionnaire (EQ-5D) consider dimensions such as physical well-being, pain, and mental health (mobility, self-care, usual activities, depression, anxiety) that may be affected by any health condition (Augustovski *et al.*, 2009). These dimensions are combined into a single indicator through 'valuation', applying population preference

weights to different health states (Brazier *et al.*, 2017). These components, measurement and valuation, underpin QALY, a generic measure of health outcomes combining quality of life (morbidity) and quantity of life (mortality) into a single measure. The QALY scale ranges from 0 (death) to 1 (full health). Measurement and valuation form the basis of the quality-adjusted life year (QALY) (Brazier *et al.*, 2017, Gray *et al.*, 2010, Weinstein and Stason, 1977, Williams, 1985).

In CUA, cost-effectiveness is expressed as an incremental cost-effectiveness ratio (ICER), representing the incremental cost per QALY gained. CUA offers advantages, including the ability to aggregate and measure effects across multiple health dimensions and the potential for comparing different health conditions or interventions (Brazier *et al.*, 2017). Currently, most published works in economic evaluation employ CUA (Drummond *et al.*, 2015). Cost-utility analysis is widely used in decision making in the UK (Buxton, 2006, Dagenais *et al.*, 2009, NICE, 2013), and its use is increasing in other European countries (Dagenais *et al.*, 2009, Schwappach and Boluarte, 2007). Currently, most published work in economic evaluation applies to CUA.

2.2.3.5 Cost-Minimization Analysis

Cost-minimization analysis (CMA) assumes two or more interventions produce equivalent health outcomes and aims to minimize costs by selecting the least expensive intervention (Gray *et al.*, 2010). This method's appeal lies in its simple analysis and interpretation (Dakin and Wordsworth, 2013). For example, a costing study evaluates only the costs of an intervention without comparing outcomes. Although partial evaluations provide valuable information, they cannot guide decision making alone, because knowing only the intervention cost or economic burden of a disease does not provide cost-effectiveness insight. To inform health care decisions on resource allocation, it is essential to assess both the costs and outcomes of the intervention and compare them with a relevant alternative or policy option (the comparator) (Zarnke *et al.*, 1997). Consequently, the applicability of cost-minimization analysis is limited, relevant primarily in rare situations where equivalent health outcomes are assumed.

2.2.3.6 Cost-Consequence Analysis

Cost-consequence analysis (CCA) calculates costs and benefits but does not aggregate them into cost-effectiveness ratios or quality-adjusted life years (QALYs) (Gold, 1996). Instead, CCA results are presented in a tabular format, with all relevant

costs and consequences disaggregated and reported separately (Brazier *et al.*, 2017, Gray *et al.*, 2010). This approach provides decision makers with flexibility to interpret, prioritize, and assign their own value weights to the tabulated costs and consequences (Coast, 2004). CCA is often used as an initial step in other economic evaluations. For instance, Roberts et al. (Roberts *et al.*, 2012) used CCA to examine the costs and benefits of partner notification models for individuals with chlamydia, gonorrhea, and non-gonococcal urethritis. The study categorized health care costs into clinical and pharmaceutical costs, along with resource data, while the outcome focused on the number of partners treated by each strategy. The authors argued that, in this exploratory study, the data collected and costs estimated in the CCA would inform future randomized controlled trials (RCTs) (Roberts *et al.*, 2012). Proponents claim this approach provides decision makers with valuable information for assessing return on investment without a full cost-effectiveness analysis (Wilkinson, 1999). In addition, CCA allows decision makers flexibility to adapt cost analyses to their unique settings and perspectives (Mauskopf *et al.*, 1998). However, a limitation is that it leaves decision makers to interpret costs and consequences of the results and assign appropriate weights to different outcomes (Gray *et al.*, 2010). This can lead to a potential lack of transparency and consistency in decisions (Drummond *et al.*, 2015). CCA is best suited as an initial technique for systematically describing interventions, especially when dealing with a wide range of costs and benefits (Kelly *et al.*, 2005, Weatherly *et al.*, 2009).

In summary, while these economic evaluation methods are well established and widely used, they are criticized for relying on maximizing utility or health gains while potentially overlooking important non-utility information and dimensions of well-being (Coast *et al.*, 2015, Al-Janabi *et al.*, 2012, Lorgelly *et al.*, 2010, Coast *et al.*, 2008a). The limitations of existing measures and calls for improved evaluation highlight the need for a more comprehensive framework and tool for assessing HRQoL outcomes and life satisfaction.

2.2.3.7 A Brief Overview of Other Potential Methods

The most widely used technique for evaluating health care programs is cost-effectiveness analysis (CEA), aiming to maximize health gains (Brouwer and Koopmanschap, 2000, Coast *et al.*, 2008b, Drummond *et al.*, 2015). However, the widespread use of CEA does not establish its superiority over cost-benefit analysis

(CBA) or other methods. In fact, CBA is standard practice in fields like environmental economics (Gafni, 2006). The use of CEA in health care is often driven by practical feasibility and decision-makers' needs (Drummond *et al.*, 2015). Traditional CBA has limitations, especially for evaluating public health interventions. Consequently, alternative methods have been proposed for evaluating public health interventions, especially those with broader effects.

Social Return on Investment (SROI), similar to CBA, has been proposed for evaluating public health interventions (Edwards *et al.*, 2013). SROI quantifies social, environmental, and economic outcomes in monetary terms, facilitating the calculation of a benefit-cost ratio (Nicholls *et al.*, 2009). Like CBA, SROI is rooted in welfare economics and shares similar limitations (Edwards *et al.*, 2013).

In traditional CEA, health outcomes are often measured in quality-adjusted life years (QALYs). However, QALYs may not capture all aspects important to decision-makers, especially in public health interventions (Cochrane *et al.*, 2019). The Capability approach (Sen, 1977) provides a comprehensive measure of health and non-health outcomes and is considered a relevant alternative (Greco *et al.*, 2016, Lorgelly *et al.*, 2010). Capabilities offer a rich set of dimensions for assessment beyond health status, making them suitable for addressing equity concerns (Lorgelly *et al.*, 2010). While capabilities could serve as a universal outcome measure in CEA, practical challenges include defining a legitimate capability space and measuring relative preferences for each capability (Lorgelly *et al.*, 2010). Pragmatic issues, like the lack of opportunity cost estimates and the need to anchor measures at zero for death, limit their use in health care resource allocation (Brazier and Tsuchiya, 2015, Coast *et al.*, 2015). Additionally, implementing the capability approach in decision-making is still in its infancy, with inconsistent guidance on using capability measures (Brazier and Tsuchiya, 2015, Coast *et al.*, 2015).

In contrast to the extra-welfarist approach to capabilities, SWB aligns with a welfarist perspective, emphasizing individual preferences and self-assessments of well-being from the intervention analyzed (Marsh *et al.*, 2012). SWB analysis is based on the principles that individuals are the best judges of their conditions and that public policy aims to maximize the sum of everyone's happiness or utility (Greco *et al.*, 2016). Nevertheless, SWB-based analysis may not address social concerns and distributional issues (Coast *et al.*, 2008a). Although measures of happiness and well-being outcomes are available (e.g., the Warwick-Edinburgh Mental Wellbeing Scale and the Wellbeing

Adjusted Life Year), SWB is still developing, with limited examples of its use in policymaking (Greco *et al.*, 2016, Marsh *et al.*, 2012). All types of economic evaluations are shown in Table 1.

Table 1 Analytical types of economics evaluations

Feature	CBA	CEA	DCEA	CUA	CMA	CCA	SROI	Capabilities	SWB
Theoretical Foundation	Welfare economics	Welfare principles, non-welfarist for health maximization	Non-welfarist, equity-focused	Non-welfarist, health-focused	Assumption of equivalent outcomes	Broad, not aggregated into ratios	Welfare economics	Beyond traditional health outcomes, focusing on a broader set of individual capabilities	Welfarist, focusing on individual preferences and self-assessments
Valuation of Outcomes	Monetary (human capital approach, willingness-to-pay)	Natural units (e.g., life years saved)	Natural units, with equity considerations	Quality-adjusted life years (QALYs)	Cost comparison only	Tabular format, not aggregated	Monetary, including social, environmental outcomes	Broad set of dimensions beyond health status	Measures of happiness and well-being
Primary Use	Assess net social benefit across sectors	Guide resource allocation by maximizing health benefits within constraints	Estimate net impact on overall health and specific population groups	Capture changes in HRQoL, combining morbidity and mortality effects	Select least expensive intervention with equivalent outcomes	Initial step in evaluations, flexibility in interpretation	Calculate benefit-cost ratio for public health interventions	Address equity concerns, comprehensive measure of health and non-health outcomes	Maximize sum of individual happiness or utility
Key Advantage	Facilitates comparisons within/across sectors	Simplified comparison using specific health outcomes	Integrates equity considerations into health interventions	Aggregates effects across multiple health dimensions, facilitates comparisons	Simplified analysis when outcomes are equivalent	Provides detailed cost and consequence overview	Quantifies broad outcomes in monetary terms	Offers a rich set of assessment dimensions, suitable for equity concerns	Emphasizes individual assessments of well-being
Main Limitation	Ethical concerns with monetizing	Limited to quantifiable health	Methodologically complex, requires	Requires valuation of QALYs,	Limited applicability, relies on	Decision makers must interpret and	Similar to CBA in welfare	Challenges in defining capability	May not address distributional

Feature	CBA	CEA	DCEA	CUA	CMA	CCA	SROI	Capabilities	SWB
	life, complex data requirements	outcomes, not allocative efficiency	detailed equity data	may not reflect all health dimensions	equivalence assumption	weigh outcomes	economics limitations, broad but complex to measure	space, measuring preferences, and anchoring measures; implementation infancy	issues, limited examples in policymaking
Measurement Methods	Human capital, willingness-to-pay	Incremental cost-effectiveness ratios (ICERs)	Social distribution of health, trade-offs between health improvement and equity	Measurement and valuation of health states through population preference weights	Cost analysis only	Disaggregated costs and consequences presented separately	Benefit-cost ratio including social and environmental outcomes	Capability space definition, relative preferences measurement	Happiness and well-being scales (e.g., Warwick-Edinburgh Scale)
Policy Implications	Can inform broad economic policies beyond health	Focused on technical efficiency, less on social welfare	Balances health improvements with reducing health inequities	Widely used in decision making, especially in UK and increasingly in Europe	Rarely used, except when outcome equivalence is assured	Informs development of future trials, flexible for decision makers' settings	Proposed for public health interventions with broad effects	Suitable for interventions with equity concerns and broader well-being impacts	Developmental stage for policy use, focuses on maximizing individual happiness
Challenges and Criticisms	Ethical concerns, complex implementation, requires extensive data	Less appropriate for different outcomes due to focus on specific health outcomes	Requires equity data, conceptually and methodologically challenging	May not capture all health dimensions, requires conversion to QALYs	Applicability limited to scenarios of outcome equivalence	Requires decision makers to assign weights without clear guidance	Broad measurement challenges, similar	Defining, quantifying capabilities, ensuring comparability, and integrating into decision-making	Measuring biases, comparing SWB across populations, policy relevance, and addressing distributional equity pose challenges in economic evaluations

2.3 Quality of Life

This comprehensive discussion explores the evolution and application of key concepts in economics, Quality of Life (QoL), HRQoL, and life satisfaction, integrating classical economics, modern theories, and practical measurements in healthcare policy and practice.

2.3.1 Utility

Utility in economics refers to the demand for goods, including healthcare, based on consumers' preferences and financial abilities (Gasper, 2007, Sen, 2008). In classical economics, utility is used as a proxy for well-being, assuming that more utility leads to better well-being. Over time, utility has been interpreted through various lenses like pleasure, desire fulfillment, and preference satisfaction. While early economists like Jeremy Bentham focused on quantifying happiness, the complexity of measuring utility led to the shift from cardinal to ordinal utility, which ranks preferences rather than numerically measuring well-being (Rojas, 2019, Jehle, 2001). This shift emphasized observable choices over subjective measures of happiness. Despite this, debates continue on how to incorporate the subjective dimension of well-being into economic analysis. In health economics, tools like Quality-Adjusted Life Years (QALYs) and Disability-Adjusted Life Years (DALYs) have emerged, combining life quantity and quality to bridge the gap between subjective well-being (SWB) and objective economic evaluation (Little, 2002, Gold *et al.*, 2002).

2.3.2 Quality of Life

The concept of QoL originates from classical Greek philosophy, particularly Aristotle's idea of the 'good life,' which emphasized virtuous activity and aspects like pleasure, honor, and wealth. In contrast, Eastern philosophies like Buddhism focus on inner peace and the cessation of suffering. Indigenous philosophies across cultures often emphasize harmony with the natural world and community well-being as integral to QoL. Contemporary understandings of QoL have evolved significantly, particularly with the emergence of the social indicators movement in the US in the 1960s (Barofsky, 2004). It's important to distinguish QoL from related concepts such as lifestyle and value of life. Lifestyle refers to an individual's behavioral patterns, coping mechanisms, motivation, and thought processes (Bowling, 2017), while QoL represents an individual's perception of life within cultural and value systems (Nov 6, 2001, Cella and Nowinski, 2002). The World Health Organization (WHO) defines QoL as an individual's holistic perception of their life in relation to goals, expectations,

standards, and concerns (Group, 1998b). This definition includes both objective factors, like income and employment, and subjective factors, like personal experiences and values. The multifaceted nature of QoL underscores its complexity. It's not a one-dimensional concept nor universally defined across disciplines. Scholars have highlighted its intricate interplay of objective and subjective dimensions. Factors influencing QoL range from tangible elements like housing and education to intangible aspects like personal perceptions and values. Furthermore, these influences vary across age groups, highlighting the need for a nuanced understanding of QoL determinants (Beckie and Hayduk, 1997, Bowling and Windsor, 1997). In health care, the conceptualization of QoL has undergone transformative changes. Historically, models focused on disease treatment. However, the mid-20th century saw a shift, with scholars like Aaron Antonovsky (Antonovsky, 1979) advocating for a broader perspective that considers factors promoting health and well-being. Developments like the Sickness Impact Profile (SIP) (Bergner *et al.*, 1981) and Nottingham Health Profile (NHP) (Hunt *et al.*, 1980) paved the way for sophisticated QoL measurement tools. The introduction of HRQoL further refined the integration of QoL into healthcare research and practice. Groundbreaking contributions from the WHO, particularly the WHOQOL instruments, marked critical advances in understanding the multidimensional nature of QoL (Group, 1998b). Today, QoL is a cornerstone of health care, influencing clinical decisions, patient-centered care approaches, and health policy formulation (Group, 1998a).

2.3.3 Health-Related Quality of Life

The brief introduction of HRQoL

The term HRQoL emerged in the 1960s, marking a shift from traditional sociological research on SWB and life satisfaction to a health-centered perspective. This shift gained momentum in the 1970s with the development of generic health status measures and preference-based measures like Quality Adjusted Life Year (QALY), enhancing healthcare planning and evaluation. HRQoL gained momentum in the 1980s with psychometric validation of instruments, increasing focus on patient quality of life in research. Since then, HRQoL has been 'corporatized' within health and social policy, signifying its importance as a comprehensive endpoint in clinical and health services research (Rapley and Ridgway, 1998) This transition underscores a patient-centered approach that goes beyond traditional clinical indicators to capture a wider array of health outcomes. Specifically, HRQoL is a critical endpoint in clinical and

health services research, embodying a patient-centered measure that transcends conventional clinical indicators to encompass a broader spectrum of health outcomes. Rooted in the biopsychosocial model, HRQoL integrates physical, psychological, and social dimensions, offering a holistic assessment of the impact of health conditions and interventions on overall quality of life (Engel, 1977). HRQoL is anchored in the World Health Organization's (WHO) definition of health, emphasizing physical, mental, and social well-being, rather than merely the absence of disease or infirmity (Romero *et al.*, 2013). This multidimensional construct reflects an individual's subjective evaluation of their health status within the context of their culture, value systems, goals, expectations, standards, and concerns (Ferrans *et al.*, 2005).

Evaluating HRQoL involves a nuanced, multidimensional approach to understanding the full spectrum of health outcomes from a patient-centric perspective. It includes domains like physical functioning and well-being, which assess an individual's ability to perform activities and manage symptoms and treatment side effects, emphasizing the importance of functional capacity in overall health (Ware Jr and Sherbourne, 1992). The psychological health domain addresses the mental and emotional consequences of health conditions, advocating for integrating mental health interventions to enhance HRQoL (Cella and Nowinski, 2002). Social functioning focuses on the impact of health on social interactions and roles, highlighting the connection between health status and social integration (Berkman and Glass, 2000). Additionally, role limitations examine the constraints health conditions place on daily activities and the ability to fulfill societal roles (Gandek *et al.*, 1998). Methods for quantifying HRQoL include direct and indirect approaches, using structured vignettes and standardized instruments like the EQ-5D. These methods capture the value individuals place on different health states, providing insights into health-related priorities and aiding in healthcare decision-making (Group, 1990). These assessments are integral to healthcare evaluation, informing clinical and policy decisions by emphasizing the patient's perspective and enabling tailored treatments. Furthermore, HRQoL data play a crucial role in the economic evaluation of healthcare interventions, contributing to cost-utility analyses vital for informed health policy decisions (Gold *et al.*, 2002).

HRQoL is pivotal in healthcare assessment, promoting a comprehensive, patient-centered perspective in medical practice and policy formulation. Its assessment requires sophisticated measurement tools to capture the full impact of health

interventions on quality of life, guiding clinical decisions and health policy to enhance patient well-being.

Preference-based measures

Utility-based approaches primarily use structured vignettes, concise depictions of hypothetical health states, to elicit preferences from the general population or specific patient groups. These vignettes gauge how individuals value different aspects of health and well-being, offering insights into health-related priorities and decision-making. Assessing these preferences helps understand variations in health state valuations across diverse groups. This is typically achieved through one or more of three techniques: the EQ Visual Analog Scales (VAS) (Green *et al.*, 2000), Time Trade-Off (TTO) (Veenhoven, 2024), and Standard Gamble (SG) (McNamee *et al.*, 2004). Each method uniquely quantifies the value individuals assign to various health states, facilitating the comparison of health outcomes and prioritization of healthcare interventions.

Conversely, indirect methods use standardized instruments, like the EQ-5D and SF-6D, to measure HRQoL. These tools have two key components: a descriptive system and utility weights. The descriptive system captures an individual's health status across various dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) through predefined questions. Responses are then converted into a single summary score using utility weights derived from population-based studies. These weights reflect societal preferences for different health states, enabling the calculation of Quality-Adjusted Life Years (QALYs) for economic evaluations and health care planning. Indirect methods provide consistent and comparable HRQoL measures across different populations and conditions, facilitating broader application in clinical and policy-making contexts.

This bifurcation into direct and indirect methods enriches the HRQoL assessment toolkit, allowing for nuanced, individualized evaluations and broad, population-level analyses. Together, these methods underscore the multifaceted nature of health outcomes and the importance of incorporating patient and societal values in healthcare decision-making (Table 2).

Table 2 Distinction between direct and indirect methods used in the assessment of HRQoL

Method	Examples	Components	Utility Source	Purpose	Application
Direct Methods	TTO (Time Trade-Off), SG (Standard Gamble), VAS (Visual Analog Scale)	Hypothetical scenarios to elicit preferences	Individual's preferences towards specific health states	To capture individual valuation of well-being and risk preferences	Detailed, individualized health state valuation
Indirect Methods	EQ-5D, SF-6D	Descriptive system; Utility weights	Societal preferences for different health states	To provide consistent and comparable HRQoL measures across populations	Broad, population-level analyses and clinical policymaking

EQ-5D measurement

The EQ-5D was developed by the EuroQol Group, a collaborative network of researchers from Europe established in 1987. The group's primary objective was to develop a standardized instrument for measuring HRQoL across diverse populations and disease states. The impetus behind the development of the EQ-5D was to facilitate healthcare decision-making by furnishing data on the cost-effectiveness of disparate treatments. The initial discussions among the group members were focused on identifying the key attributes of health status that could be universally relevant. The original instrument, which was launched in the early 1990s, comprised six dimensions. However, subsequent empirical testing led to a refinement of the instrument, which was finalized with five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression (Devlin and Brooks, 2017).

The instrument was originally designated the 'EuroQol Instrument', but in 1995 it was formally designated EQ-5D. The initial version, EQ-5D-3L, included three levels of severity for each dimension (no problems, some problems, extreme problems), allowing for a total of 243 different health states. Despite its widespread adoption in clinical trials, population surveys, and health economics, the EQ-5D-3L was subject to limitations, including ceiling effects, whereby the instrument was unable to effectively discriminate between minor health changes in relatively healthy populations. To address these limitations, the EuroQol Group developed an enhanced version, the EQ-5D-5L, which was introduced in 2009. The new version expanded

each dimension to encompass five levels of severity: no problems, slight problems, moderate problems, severe problems, and extreme problems. This expansion permitted a more detailed evaluation of health states and enhanced the tool's responsiveness to changes, particularly among patients with mild to moderate conditions (Herdman *et al.*, 2011, Devlin and Brooks, 2017, Van Hout *et al.*, 2012).

Additional comparative studies between the EQ-5D-3L and the EQ-5D-5L have revealed that the 5L version yields more precise measurements, with superior distributional characteristics, greater sensitivity, and diminished bias in utility estimation. Specifically, the EQ-5D-5L has demonstrated enhanced discriminatory power, particularly in differentiating between mild and moderate/severe health condition (Devlin and Brooks, 2017). The 5L version is therefore preferable for both clinical studies and health economic evaluations, as it reduces the likelihood of overestimating or underestimating health problems, a common issue with the 3L version (Devlin and Brooks, 2017).

The EQ-5D has become a globally recognized tool for measuring health outcomes and is widely employed in health technology assessments (HTAs). As of 2016, the instrument has been recommended in the guidelines for healthcare decision-making in over 80 countries. The tool is available in a variety of formats to accommodate different modes of administration, including paper versions, digital formats (web-based, tablet, and PDA), and different settings such as proxy responses or telephone interviews. The EQ-5D-3L is currently available in 176 languages, while the EQ-5D-5L is available in 138 languages, ensuring its applicability across diverse linguistic and cultural contexts (Devlin and Brooks, 2017, Van Hout *et al.*, 2012). Furthermore, the EQ-5D has a comprehensive range of value sets, comprising 25 for the EQ-5D-3L and 22 for the EQ-5D-5L (EUROQOL). These value sets are indispensable for transforming descriptive health states into a unified summary index value in accordance with population preferences. A number of countries, including Argentina, Canada, China, England, Hong Kong, Japan, the Netherlands, and Spain, have already established value sets. Several others, including Germany, Indonesia, Ireland, Norway, Singapore, South Korea, Thailand, and the UK, are currently developing or planning to develop their own value sets (Devlin and Brooks, 2017, Herdman *et al.*, 2011, EUROQOL). These value sets are essential for facilitating cross-country comparisons and supporting economic evaluations of health interventions. Recent developments have seen the mapping of the EQ-5D-5L to EQ-5D-3L value sets using a variety of

statistical models, including linear regression, nonparametric statistics, and ordered logistic regression. This mapping approach is particularly useful in settings where direct valuation studies for the EQ-5D-5L are not yet available (Van Hout *et al.*, 2012).

The research comparing EQ-5D-3L and EQ-5D-5L across multiple countries, including Canada, China, England, Japan, the Netherlands, South Korea, and Spain, has demonstrated that the 5L version not only provides a more even distribution of utility values but also exhibits superior discriminatory performance. This superiority is evident in both parametric and non-parametric measures, with the 5L version consistently outperforming the 3L version in various tests of relative efficiency and area under the curve (AUROC) analysis (Janssen *et al.*, 2018). Recent analyses have demonstrated significant discrepancies in the EQ-5D-5L utility indices based on country-specific value sets, which can influence the interpretation of clinical study results. For instance, the discrepancy in utility values for an identical health state can be considerable between countries, largely attributable to cultural, environmental, and healthcare system discrepancies. For the 3125 potential health states, the median discrepancy in the utility index between countries with the highest and lowest values was 0.417 for the crosswalk value sets, underscoring the necessity for country-specific assessments in multinational clinical studies (Gerlinger *et al.*, 2019).

The EQ-5D tool offers a standardized methodology for evaluating five domains of health: The five dimensions of health assessed by the EQ-5D tool are mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The original EQ-5D-3L employs a three-level scale for each dimension, with the objective of indicating the severity of problems. In contrast, the EQ-5D-5L employs a five-level scale that provides a more detailed assessment, with the following categories: no problems, slight problems, moderate problems, severe problems, and extreme problems. A distinctive aspect of the EQ-5D is the Visual Analog Scale (EQ VAS), which enables respondents to assess their overall health on a scale from 0 (representing the worst imaginable health state) to 100 (representing the best imaginable health state). This provides a quantitative measure of the patient's overall health status, which serves to complement the descriptive system. The development of the EQ-5D-5L was guided by the necessity to enhance the instrument's sensitivity and mitigate ceiling effects, particularly in populations with mild to moderate health conditions. The process entailed the identification and validation of suitable labels for the new levels through a series of focus groups and response scaling exercises. The selected labels were "no

problems," "slight problems," "moderate problems," "severe problems," and "extreme problems," which reflected a range of health states from optimal health to severe impairment. The EQ-5D-5L exhibited enhanced measurement properties in comparison to the EQ-5D-3L, as evidenced by findings across a range of studies and patient groups. For example, a multinational study comprising eight patient groups demonstrated that the EQ-5D-5L exhibited a markedly reduced ceiling effect (decreasing from 20.2% in the EQ-5D-3L to 16.0% in the EQ-5D-5L) and a considerably enhanced absolute discriminatory power (Shannon index increasing from 1.24 to 1.87). Furthermore, the EQ-5D-5L exhibited enhanced convergent validity with the WHO-5 Well-Being Index and demonstrated consistent known-groups validity across diverse socio-demographic groups, including age, education, and smoking status (Herdman *et al.*, 2011). The findings indicated that the new five-level system provided a more accurate reflection of health status across a broader range of conditions (Herdman *et al.*, 2011). The combination of the descriptive system and the EQ VAS allows the tool to be versatile for various types of studies, including clinical trials, population health surveys, and routine outcome measurement in healthcare settings (Devlin and Brooks, 2017).

The EQ-5D continues to serve as a cornerstone in the fields of health economics and clinical research, undergoing continuous evolution to align with the evolving needs of healthcare decision-makers. The instrument is valued for its simplicity and ease of use, which contribute to its popularity in health outcome studies. The instrument can be utilized to generate a single index value for health status, which can then be employed in health economics evaluations, such as the calculation of quality-adjusted life years (QALYs). This instrument is applicable across a wide range of health conditions and treatments, rendering it versatile for use in numerous contexts, including during the ongoing pandemic to assess the impact on general health and quality of life (Devlin and Brooks, 2017). The EuroQol Group is committed to further refining the tool, including the development of new value sets and enhancements to cross-cultural comparability, thereby ensuring its ongoing relevance and utility in a rapidly changing healthcare landscape. Future research will focus on further validating the EQ-5D-5L across diverse populations and developing new applications beyond traditional clinical and economic evaluations.

2.3.4 Subjective Well-Being and Life Satisfaction

Concept of Subjective Well-Being

SWB is a comprehensive term that describes how people experience the quality of their lives, encompassing both emotional reactions and cognitive judgments. The global impact of the COVID-19 pandemic on human health has highlighted the importance of understanding SWB as individuals and communities face significant challenges. Lyubomirsky et al. defined SWB as 'the experience of joy, contentment, or positive well-being, combined with a sense that one's life is good, meaningful, and worthwhile' (Lyubomirsky, 2014). The study of SWB is:

'The scientific analysis of how people evaluate their lives—both at the moment and for longer periods such as for the past year people's emotional reactions to events, their moods, and judgments they form about their life satisfaction, fulfillment, and satisfaction with domains such as marriage and work (Diener *et al.*, 2003)'.

SWB is a complex construct encapsulating individuals' perceptions and feelings about their lives. Its study necessitates clear definitions, robust theories, and an understanding of how these elements interplay to effectively predict and explain these phenomena. Conceptions of SWB are critical as they guide measurement strategies, influencing the comparability of findings across various studies (Maddux *et al.*, 2019). A persistent challenge in SWB research is the lack of consensus on its definition and measurement, leading to debates centered around two primary conceptions: hedonic and eudaimonic well-being. Hedonic well-being is defined by the balance of pleasure over pain, with life satisfaction derived from the frequency and intensity of positive versus negative experiences (Haybron, 2008). This conception emphasizes subjective evaluations of life quality, independent of moral or societal standards, positioning the individual as the sole arbiter of their happiness and satisfaction. Conversely, eudaimonic well-being, rooted in Aristotelian philosophy, posits that true well-being is achieved through realizing one's potential and engaging in meaningful activities beyond mere pleasure (Haybron, 2008, Ruini and Ryff, 2016). This approach emphasizes personal growth, autonomy, purpose in life, and mastery over one's environment, which constitute a more profound and ethically grounded form of well-being. Discussions about hedonic and eudaimonic SWB often imply a 'moral hierarchy', suggesting that eudaimonic well-being is more ethical or 'authentic' than hedonic well-being. However, these debates are philosophical and moral, not scientific, as conceptions of SWB are social constructions influenced by cultural values and beliefs, not objective scientific truths. Different cultures have varied views on what constitutes well-being, with Eastern cultures emphasizing low-arousal emotions and

self-transcendence, while Western cultures value high-arousal emotions and self-enhancement. Scientific research cannot prove one conception of SWB as superior to another because these are fundamentally moral and ethical issues (Maddux, 2017).

Although research cannot support or refute conceptions of SWB, it can support or refute theories of SWB because theories make predictions about the relation between variables or the effect of one variable on another. The two basic types of SWB theories with considerable research are life circumstance theories (bottom-up theories) and dispositional/construal theories (top-down theories). Life circumstance theories, also known as bottom-up theories, suggest SWB is primarily influenced by the accumulation of positive and negative life circumstances. These include everyday experiences (major and minor) and broader demographic factors such as socioeconomic status, education, and physical health (Lyubomirsky and Dickerhoof, 2010). According to these theories, individuals born into advantageous circumstances or experiencing more positive events than negative ones tend to have higher SWB. Life satisfaction and overall SWB are thought to result from satisfaction across various life domains (e.g., work, family), where positive and negative events and emotions occur. Empirical support for life circumstance theories is underscored by several key research findings. A longitudinal study by Chen et al. demonstrated that satisfaction with one's team can significantly influence overall life satisfaction over time (Chen *et al.*, 2018). Research by Lance et al. found that marital satisfaction can predict life satisfaction, but not the other way around (Lance *et al.*, 1989). Scherpenzeel and Saris showed that satisfaction with housing, financial situation, and social life are strong predictors of overall life satisfaction (Scherpenzeel and Saris, 1996). Blustein highlighted the impact of employment status and satisfaction on SWB and mental health (Blustein, 2008). Despite these findings, life circumstances account for only about 10% of the population-wide differences in SWB, indicating that other factors also play a significant role (Lyubomirsky and Dickerhoof, 2010). Dispositional theories, also known as top-down or construal theories, propose that SWB is primarily shaped by inherent biological or temperamental factors. These factors influence behaviors and cognitive processes, such as how individuals interpret and appraise life circumstances and events, which in turn affect their SWB (Lyubomirsky and Dickerhoof, 2010). Evidence suggests strong genetic influences on how people perceive positive and negative events, making these theories both dispositional and construal based. Supporting research provides compelling evidence for the genetic and

dispositional influences on SWB. Notably, Lykken et al. found that genetic predisposition accounts for significant portions of SWB variance, with estimates up to 50% for current SWB and 80% for long-term differences (Lykken and Tellegen, 1996). Lykken et al. further demonstrated that identical twins raised apart show more similarity in SWB compared to fraternal twins raised together, underscoring the genetic contribution (Lykken, 1999). Steel et al. highlighted the role of genetic factors in establishing an SWB set point to which individuals typically return following changes in SWB due to life events (Steel *et al.*, 2008). Extensive research on the heritability of personality traits, such as neuroticism and extraversion, reveals strong relationships between these traits and SWB. Higher neuroticism is associated with lower SWB, while higher extraversion correlates with greater SWB. Dispositional and construal theories receive support from social neuroscience research, which examines how brain processes related to social interactions and cognitive functions impact SWB. The brain's default network, crucial for social cognition and emotional regulation, plays an essential role in maintaining SWB. This integrated body of research underscores the significant influence of genetic and dispositional factors on SWB alongside life circumstances. Both life circumstance and dispositional/construal theories offer valuable insights into the factors that influence SWB. Life circumstance theories emphasize the role of external conditions and experiences, while dispositional/construal theories highlight the importance of internal inherent factors. Together, these theories provide a comprehensive understanding of the determinants of SWB, guiding research and interventions aimed at enhancing well-being.

Different Strategies for Measuring Subjective Well-Being

Despite the inherent challenges in developing measures for SWB and related constructs, numerous scales have been developed. Some of these scales focus exclusively on the affective components of SWB, others solely on life satisfaction, while some encompass both. Measures primarily affective, especially those assessing 'in-the-moment' affect, are viewed as measures of experienced well-being. Conversely, measures of life satisfaction, which evaluate life events and experiences over extended periods, are seen as measures of evaluated well-being (Kahneman and Riis, 2005). The most well-researched conceptions and measures include the tripartite model of hedonic SWB, measures of affect and happiness, measures of life satisfaction, and measures of eudaimonic SWB.

The tripartite model is the most well-constructed model of hedonic SWB. This model views SWB as comprising positive affect, negative affect, and life satisfaction. Life satisfaction can be both general (overall satisfaction with life) and domain-specific (satisfaction with specific life domains such as work and relationships) (Busseri and Sadava, 2011). Measures of life and domain satisfaction are cognitive evaluations based on beliefs about one's life, while measures of positive and negative affect are emotional assessments of the frequency of pleasant and unpleasant feelings (Schimmack, 2008). Positive and negative affects are not independent but are separable experiences that can occur simultaneously, with correlations between them usually being weak to moderate (Bradburn and Caplovitz, 1965, Schimmack, 2008, Diener, 1984, Diener *et al.*, 2003, Pavot, 2008). Factor analytic research has identified five different configurations of the relationships among life satisfaction, positive affect, and negative affect (Busseri and Sadava, 2011). The Separate Components Model studies SWB as distinct components without implying causal connections among them, despite potential strong correlations. The Hierarchical Construct Model posits SWB as a higher-order latent factor that produces correlations among its three lower-order components. The Causal System Model views SWB as a network where positive and negative affects independently influence life satisfaction, with individuals using their emotional balance to evaluate their life satisfaction. The Composite Model sees SWB as a combination of positive affect, negative affect, and life satisfaction, requiring the assessment of all three components. The Configuration Model suggests that configurations of positive affect, negative affect, and life satisfaction vary among individuals, indicating that a single structure might not be applicable to everyone. Given that three of these models involve all major components of SWB, it is advisable to assess all three components when measuring SWB (Busseri and Sadava, 2011). The relationship between overall life satisfaction and domain-specific satisfaction can be conceptualized as both bottom-up and top-down (Schimmack, 2008). In a bottom-up relationship, individuals develop satisfaction within specific life domains first, which collectively contribute to their overall life satisfaction. Conversely, in a top-down relationship, people first develop a general sense of overall life satisfaction, which subsequently influences their evaluations of specific life domains (Schimmack, 2008).

The Positive and Negative Affective Schedule (PANAS) is a widely used measure of affect and happiness, with 10 positive and 10 negative adjectives rated on a 5-point scale, though its distinction between positive and negative affect has been questioned

(Mattek *et al.*, 2017). The Affect Balance Scale assesses affective experiences using 10 items, creating a balance score by subtracting negative from positive affect (Pavot, 2008). The expanded Affectometer 2 (Kammann and Flett, 1983) includes 40 items covering ten SWB aspects, showing high consistency and validity (Kammann and Flett, 1983, Pavot, 2008). The Fordyce Happiness Measure (FHM) includes an 11-point happiness item and three percentage-based items, demonstrating good reliability and validity (Fordyce, 1988). The experience sampling method (ESM) collects real-time affect data throughout the day, reducing memory bias (Schwarz and Strack, 1999), but can be complex to interpret (Pavot, 2008, Scollon *et al.*, 2003). The day reconstruction method (DRM) efficiently records the previous day's activities, showing moderate correlations with self-reports (Kahneman and Krueger, 2006, Pavot, 2008). The U-index measures time spent in pleasant or unpleasant states (Kahneman and Krueger, 2006, Krueger, 2009), while informant reports from acquaintances and facial expression ratings correlate well with self-reports of SWB (Pavot, 2008, Pavot *et al.*, 1991).

Measuring life satisfaction is crucial for assessing subjective well-being and uses several established scales. The SWLS by Diener et al. includes five items evaluating overall life contentment (Diener *et al.*, 1985). The Temporal Satisfaction with Life Scale (TSWLS) extends this by assessing past, present, and future satisfaction through 15 items. Cantril's Ladder (CANTRIL) is a visual scale from zero (worst possible life) to ten (best possible life), allowing individuals to rate their current life satisfaction. For children and adolescents, the Multidimensional Students' Life Satisfaction Scale (MSLSS) by Huebner measures satisfaction across domains like family and school (Huebner, 1994). The Life Satisfaction Scale for older adults by Neugarten et al. assesses factors such as zest for life and goal achievement (Neugarten *et al.*, 1961). These instruments help identify factors influencing life satisfaction, aiding in the development of well-being interventions.

To measure eudaimonic SWB, the Scales of Psychological Well-Being (SPWB), which is the most frequently used tool, consists of 89 items rated from strongly disagree (1) to strongly agree (6) and includes six subscales: self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth (Ryff, 1989). The SPWB demonstrates good construct validity, internal consistency, and test-retest reliability (Crouch *et al.*, 2017, Ryff, 2013), and correlates highly with measures of life satisfaction, positive affect, and negative affect (Crouch

et al., 2017, Feist *et al.*, 1995). The Oxford Happiness Inventory (OHI) and its revision, the Oxford Happiness Questionnaire are 29-item scales assessing emotional experiences and life satisfaction, including energy level, optimism, perceived control, perceived health, social interest, congruence between goals and achievements, and general happiness (Hills and Argyle, 2002, Pavot, 2008). Other eudaimonic measures used less frequently in research include the Personally Expressive Activities Questionnaire (Waterman, 1993), the Questionnaire for Eudaimonic Well-Being (Waterman, 2010), and the Mental Health Continuum (Keyes, 2006, Huta, 2014) (Table 3).

Table 3 Comprehensive strategies for measuring subjective well-being (SWB)

Measure		Description	Focus
Measurement of Hedonic SWB			
Tripartite Model of Hedonic SWB		Comprises positive affect, negative affect, and life satisfaction. Positive and negative effects are separable experiences, with weak to moderate correlations between them	General SWB
Measures of Affect and Happiness	Positive and Negative Affective Schedule (PANAS)	10 positive and 10 negative adjectives rated on a 5-point scale	Affect and happiness
	Affect Balance Scale	Assesses affective experiences using 10 items, creating a balance score by subtracting negative from positive affect	Affective experiences
	Affectometer 2	Includes 40 items covering ten SWB aspects, showing high consistency and validity	SWB aspects
	Fordyce Happiness Measure (FHM)	Includes an 11-point happiness item and three percentage-based items, demonstrating good reliability and validity	Happiness
	Experience Sampling Method (ESM)	Collects real-time affect data throughout the day, reducing memory bias	In-the-moment affect
	Day Reconstruction Method (DRM)	Efficiently records previous day's activities, showing moderate correlations with self-reports	Daily activities
	U-index	Measures time spent in pleasant or unpleasant states	Affect
	Informant Reports	Reports from acquaintances and facial expression ratings correlate well with self-reports of SWB	Perceived SWB
Measures of life satisfaction	Satisfaction With Life Scale (SWLS)	Includes five items evaluating overall life contentment	Life satisfaction
	Temporal Satisfaction with	Assesses past, present, and future satisfaction through 15 items	Temporal life satisfaction

	Life Scale (TSWLS)		
	Cantril's Ladder	Visual scale from zero (worst possible life) to ten (best possible life) allowing individuals to rate their current life satisfaction	Life satisfaction
	Multidimensional Students' Life Satisfaction Scale (MSLSS)	Measures satisfaction across domains like family and school for children and adolescents	Domain-specific satisfaction
	Life Satisfaction Scale for Older Adults	Assesses factors such as zest for life and goal achievement	Life satisfaction
Measures of Eudaimonic Well- Being	Scales of Psychological Well-Being (SPWB)	89 items rated from strongly disagree (1) to strongly agree (6), including six subscales: self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth	Eudaimonic SWB
	Oxford Happiness Inventory (OHI)	29-item scales assessing emotional experiences and life satisfaction, including energy level, optimism, perceived control, perceived health, social interest, congruence between goals and achievements, and general happiness	Eudaimonic SWB
	Personally Expressive Activities Questionnaire	Measures eudaimonic activities and personal growth	Eudaimonic SWB
	Questionnaire for Eudaimonic Well-Being	Assesses eudaimonic well-being	Eudaimonic SWB
	Mental Health Continuum	Measures positive mental health, including emotional, psychological, and social well-being	Eudaimonic SWB

SWLS measurement

The SWLS was developed in 1985 by Ed Diener and colleagues. The SWLS was developed with the objective of providing a concise, global assessment of an individual's overall cognitive judgments regarding their life satisfaction. This instrument serves as a pivotal component within the domain of SWB research. The creation of the SWLS marked a pivotal shift within the field of psychology, whereby the study of positive psychological states, such as happiness and life satisfaction, gained prominence, effectively counterbalancing the traditional focus on negative states like depression and anxiety (Diener *et al.*, 1985). In its initial stages of development, the SWLS comprised a pool of 48 items designed to reflect life satisfaction and well-being. A factor analysis of the initial pool of items revealed that 10 items exhibited high loadings (0.60 or above) on a single factor representing global life satisfaction. Further refinement of the scale resulted in a reduction to the final five

items, which had minimal effect on the alpha reliability of the scale (Pavot and Diener, 1993). The final version employs a 7-point Likert scale, ranging from 1 (indicating strong disagreement) to 7 (indicating strong agreement), thus allowing for a range of possible scores from 5 to 35. The neutral point is represented by a score of 20 (Pavot and Diener, 1993, Diener, 1984). The SWLS has been subjected to rigorous psychometric evaluation since its inception. The scale has been validated for use across a wide range of populations and is notable for its simplicity, brevity, and ease of administration, which make it suitable for various research settings (Pavot and Diener, 2008). Studies have consistently demonstrated the reliability of the SWLS as a measure of life satisfaction, with a single-factor solution accounting for a significant portion of the variance (approximately 60-67% across different samples) (Diener *et al.*, 1985, Pavot and Diener, 1993, Diener *et al.*, 2013).

The SWLS has gained international recognition and is a widely utilized instrument in research across a range of countries and cultural contexts. The scale has been translated into over 30 languages, including Spanish, French, German, Japanese, Chinese, Korean, Russian, Czech, and Arabic. These translations have facilitated its use in cross-cultural studies on life satisfaction and subjective well-being (Arrindell *et al.*, 2022). While specific guidelines do not formally recommend the SWLS for use in funding decision-making in many countries, it is frequently utilized in public health and psychological research to assess quality of life, particularly in studies related to health outcomes, aging, and mental health. Its deployment in a multitude of research contexts underscores its adaptability and extensive utility in evaluating subjective life satisfaction across diverse populations (Diener *et al.*, 2013). Notwithstanding its extensive utilization in public health and psychological research, specific national guidelines do not typically endorse the SWLS for incorporation into funding decision-making processes. However, the scale's flexibility and adaptability have resulted in its frequent utilization in studies assessing quality of life, particularly with regard to health outcomes, aging, and mental health (van Beuningen, 2012, Diener, 2000).

The SWLS is a subjective measure of life satisfaction that does not convert responses into utility scores or indices for economic evaluations. The SWLS is comprised of five statements, designed to capture an individual's global assessment of life satisfaction:

1. In most ways, my life is close to my ideal.
2. The conditions of my life are excellent.

3. I am satisfied with my life.
4. So far, I have gotten the important things I want in life.
5. If I could live my life over, I would change almost nothing.

Respondents rate their agreement with each statement on a 7-point Likert scale, and the scores are summed to produce a total score. The scoring is typically interpreted as follows:

31-35: Extremely satisfied

26-30: Satisfied

21-25: Slightly satisfied

20: Neutral

15-19: Slightly dissatisfied

10-14: Dissatisfied

5-9: Extremely dissatisfied

The SWLS has been shown to have high internal consistency, with Cronbach's alpha values generally ranging from 0.79 to 0.89, demonstrating good reliability across diverse samples (Pavot and Diener, 1993). The scale also shows strong temporal stability, with test-retest correlations remaining moderate to high over periods ranging from several weeks to several years, although longer intervals naturally result in lower correlations due to the increased likelihood of life events influencing satisfaction (Lucas *et al.*, 1996).

Extensive research has confirmed the SWLS's construct validity. The scale exhibits high convergent validity, correlating significantly with other measures of life satisfaction and well-being, while showing lower correlations with unrelated constructs such as affective states, which supports its discriminant validity (Pavot and Diener, 1993, Lucas *et al.*, 1996). For instance, the SWLS has been shown to correlate more strongly with a single-item measure of global life satisfaction ($r = 0.56$) than with the Mental Health Inventory (MHI-5) (Ware Jr and Sherbourne, 1992). Moreover, the scale has demonstrated nomological validity, correlating as expected with constructs theoretically related to life satisfaction, such as health and socio-demographic factors (Diener *et al.*, 1999, van Beuningen, 2012). Health, for example, is one of the most significant predictors of life satisfaction, and the SWLS has been used to explore this relationship across various contexts (Diener *et al.*, 1999).

The SWLS is widely used in both clinical and non-clinical settings. In clinical psychology, it is often employed to assess the effectiveness of therapeutic interventions aimed at improving life satisfaction and overall well-being. It has been used to evaluate the life satisfaction of individuals with various health conditions, such as those with traumatic brain injury, spinal cord injury, and chronic illnesses (Diener and Seligman, 2002). In non-clinical settings, the SWLS is utilized in studies examining factors that influence subjective well-being, including personality traits, social relationships, and cultural influences (Lyubomirsky *et al.*, 2005). Research has demonstrated that life satisfaction, as measured by the SWLS, is a significant predictor of important life outcomes, including physical health, mental health, and social functioning. Higher life satisfaction scores are associated with lower risks of suicide, better physical health, and greater resilience in the face of stress (Koivumaa-Honkanen *et al.*, 2001). The scale's simplicity and ease of administration make it a valuable tool for both researchers and clinicians (Pavot and Diener, 2008).

The SWLS continues to serve as a pivotal instrument in the domain of positive psychology and subjective well-being research. The scale's robustness, ease of use, and applicability across diverse populations and settings make it an essential instrument for measuring life satisfaction. Future research may focus on further exploring the cultural nuances of life satisfaction judgments and the long-term predictive power of life satisfaction for various life outcomes. Additionally, continued development of value sets and translations will enhance the scale's utility in global research efforts (Diener *et al.*, 1999, Pavot and Diener, 2008).

3 Literature Review of Studies Reporting Health-Related Quality of Life during COVID-19 Pandemic

This review thoroughly analyzes existing literature on the effects of the COVID-19 pandemic on individuals' HRQoL and subjective well-being. It synthesizes findings on HRQoL, life satisfaction, and anxiety/depression levels across various populations, including COVID-19 survivors, individuals with different health conditions, and the general population. By examining both HRQoL and psychological outcomes, the review provides an integrated perspective on the pandemic's broader impact. It identifies patterns, risk factors, and protective factors associated with these outcomes, highlights specific needs for different groups, and provides evidence-based recommendations for healthcare providers, policymakers, and health practitioners to address these health challenges during the pandemic.

3.1 Study Design and Data Collection of HRQoL Literature

3.1.1 Study Design of HRQoL Literature

Search strategy

A systematic search of PubMed electronic bibliographic databases was conducted from 2020 to May 2022 to assess HRQoL utility values using both direct measures (Standard Gamble [SG], Time Trade-Off [TTO], and Visual Analogue Scale [VAS]) and indirect measure (questionnaires such as EQ-5D, SF-6D, and HUI). To improve specificity and minimize the retrieval of non-relevant articles, terms were searched in titles and abstracts, e.g., [SG (abstract/title)]. This approach aimed to focus on the search results on studies directly relevant to our research. Additionally, we extended our search to include key terms related to quality-adjusted life years and health state utility, such as 'preference-based quality of life', 'health state utilities', and 'health utility', following the recommendations of health economists (Papaioannou *et al.*, 2013, Saeed *et al.*, 2020) (Appendix Table 1). Our search aimed to provide a comprehensive global overview, without geographical limitations, reflecting the diverse impact of the pandemic worldwide. We applied inclusion and exclusion criteria to refine the search results, ensuring relevance and focus on our research objectives.

Inclusion and Exclusion Criteria

Articles were included in our review based on the following criteria: (a) reports presenting health state utility values (HSUVs) related to COVID-19 collected between

2020 and 2022; (b) publications in English in peer-reviewed journals; (c) presentation of original HSUV data; and (d) use of direct or indirect methods to quantify HRQoL**.**

3.1.2 Study Selection and Data Extraction

This literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The study selection process, outlined in Figure 1, focused on HRQoL review. One reviewer (Xu) conducted the initial study selection, and a second reviewer (BV) verified the data quality. The search results were imported into Excel for de-duplication. At the title and abstract screening stage, an inclusive strategy was used to retrieve publications that met the inclusion criteria and those with uncertain eligibility based on their title or abstract alone. These were then fully assessed based on their full text. The selection process consisted of three steps: first, duplicates were removed using Excel; second, titles and abstracts were screened against the inclusion/exclusion criteria using a keyword search, and excluded articles were removed; third, articles with uncertain eligibility were assessed in their full text versions against the inclusion/exclusion criteria. An Excel form was prepared for data extraction from articles that passed the second stage.

A pre-designed Excel spreadsheet facilitated systematic data collection, recording key details from each eligible study, including (1) first author, year of publication; (2) country of research; (3) study title; (4) sample characteristics; (5) morbidity; (6) study design; (7) data collection method; (8) survey period; (9) HRQoL instrument(s) or utility measures (e.g., EQ-5D); (10) sample size; (11) health state description; and (12) mean health state utility (with standard deviation). All qualifying studies were identifiable after data compilation in Excel. We extracted directly reported utilities and, where necessary, converted utility scores from a scale of 0 to 100 to a scale of 0 to 1 for consistency. Numerical information was meticulously extracted from graphical presentations when not directly reported in text or tables. Aggregated utility scores were systematically tabulated and summarized for analysis (Table 4 and Appendix Table 2).

3.2 Results of the systematic literature search

3.2.1 Characteristics of Included HRQoL Studies

Our initial PubMed search generated 1,052 articles on the COVID-19 outbreak from 2020 to 2022. After a detailed title and abstract screening and full-text review (illustrated in Figure 1), we identified 37 studies (Alinia *et al.*, 2021, Arab-Zozani *et*

al., 2020, Azizi *et al.*, 2020, Bauerle *et al.*, 2020, Beisani *et al.*, 2021, Douglas *et al.*, 2021, Ferreira *et al.*, 2021a, Gamberini *et al.*, 2021, Garrigues *et al.*, 2020, Giusiano *et al.*, 2021, Guo *et al.*, 2020, Halpin *et al.*, 2021, Hay *et al.*, 2021, Iqbal *et al.*, 2021, Lara *et al.*, 2020, Lim *et al.*, 2020, Machado *et al.*, 2021, Manh Than *et al.*, 2020, Matthew, 2021, Meys *et al.*, 2020, Musche *et al.*, 2020, N. D. Clement, 2021, Ohta *et al.*, 2022, Ordinola Navarro *et al.*, 2021, Ping *et al.*, 2020, Sacristán-Galisteo *et al.*, 2022, Said *et al.*, 2022, Szabo *et al.*, 2020, Todt *et al.*, 2021, Turcu-Stiolica *et al.*, 2021, Ungureanu *et al.*, 2020, van Ruth *et al.*, 2021, Vu *et al.*, 2020, Walle-Hansen *et al.*, 2021, Wong *et al.*, 2022, Xu *et al.*, 2022, Zhou *et al.*, 2022) meeting our inclusion criteria. These studies assessed post-discharge persistent symptoms, rehabilitation needs, and HRQoL impacts among the general population, COVID-19 survivors, and specific disease groups. Among these, 31 were cross-sectional studies, four were cohort studies, one was a decision-making study, and one was a longitudinal study. The methodologies varied: twenty studies used online self-completed questionnaire, six used paper-based self-completed questionnaire, eight conducted phone interviews (questionnaire), three used private interviews, and three that examined patient healthcare records. These studies spanned five continents: Europe (n=20), North America (n=4), Asia (n=11), South America (n=1), and Africa (n=1), reflecting wide geographic diversity. The HRQoL instruments included 15D (n=3), EQ-5D-5L (n=24), EQ-5D-3L (n=8), VAS (n=1), and TTO (n=1), covering a broad spectrum of health state utility measurements (Table 5).

A significant portion of the research focused on diverse populations, with sample size ranging from forty (Spain, Alzheimer's disease patients) to 15,037 (Germany, general population). Specifically, 14 studies (representing 30.29 % of the study population) addressed a board population of COVID-19 infection cases, while seven studies (representing 5. 89% of the total population) focused on respondents with specific diseases, including Alzheimer's disease (AD) and amnesic mild cognitive impairment (MCI) (Lara *et al.*, 2020), cardiovascular disease (Lim *et al.*, 2020), skin disease (Guo *et al.*, 2020), total hip (THA) or knee arthroplasty (KA) or partial knee arthroplasty (PKA) (N. D. Clement, 2021), cancer (Musche *et al.*, 2020), bariatric surgery (Beisani *et al.*, 2021), and amyotrophic lateral sclerosis (Giusiano *et al.*, 2021). Each of these was reported in single study (Table 5).

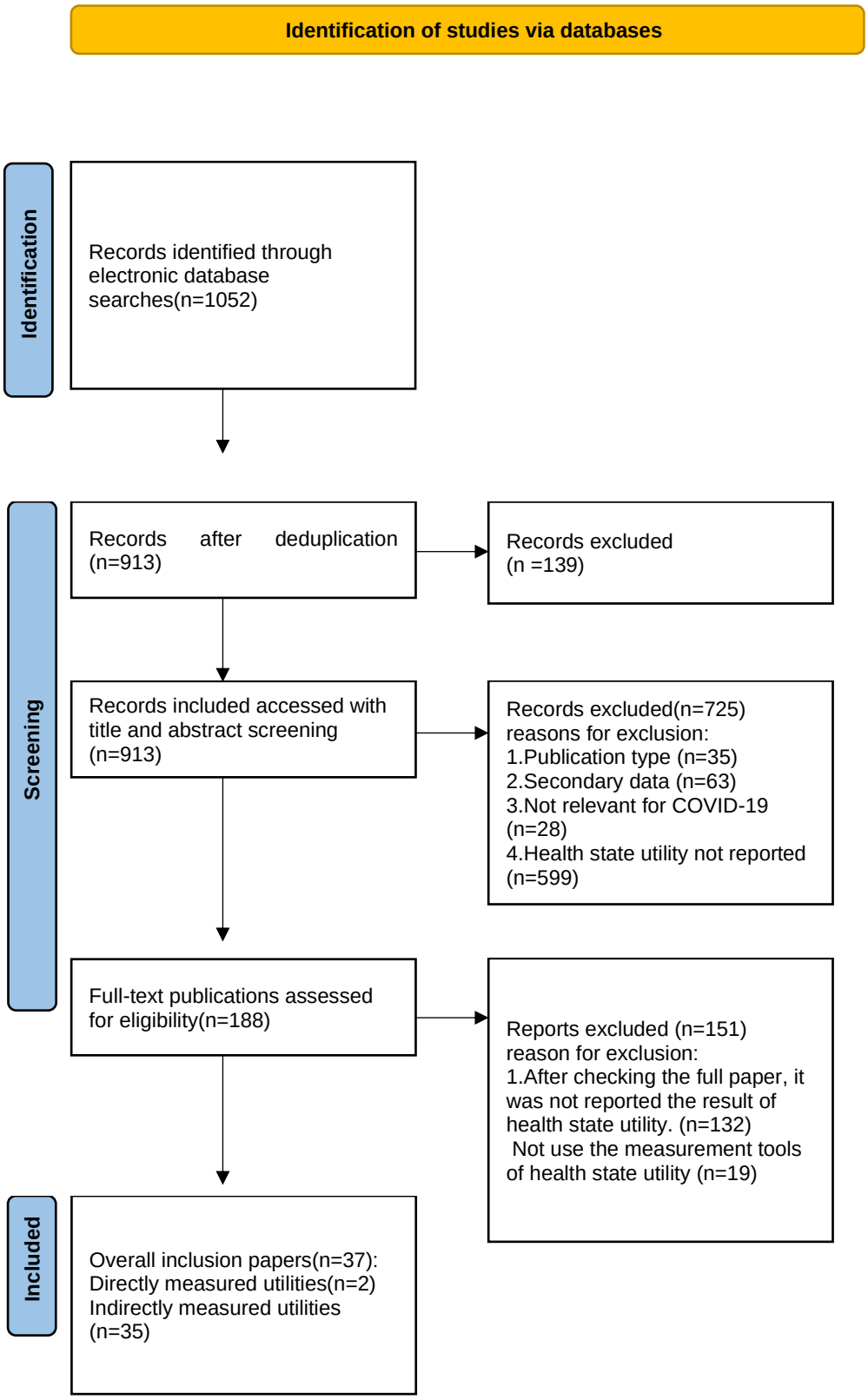


***Figure** 1 Flow diagram for HRQoL. the number of records identified, included, and excluded at each stage of the review, and the reasons for exclusions*

Table 4 Characteristics of the HRQoL literature included

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
1	Halpin et al.	2020	UK	Adult patients were infected by COVID-19 within Leeds metropolitan district and discharged from LTHT hospital	Covid infection	05/2020-06/2020	EQ-5D-5L	100	--	--
2	Garrigues et al.	2020	France	French speaking patients who were hospitalized in COVID-19 ward unit more than 100 days after their admission and discharged at the time of study	Covid infection	15/03/2020-14/04/2020	EQ-5D-5L	120	Overall	0.86
3	Ping et al.	2020	China	Non-representative sample of the Changzhi city population	No	02/03/2020-10/03/2020	EQ-5D-3L	1139	Overall	0.949
4	Benítez et al.	2020	Spain	Patients older than 60 diagnosed of amnesic mild cognitive impairment or mild AD were recruited from a single neurology center	No (Alzheimer's disease (AD) and amnesic mild cognitive impairment (MCI))	03/2020	EQ-5D-5L	40	Overall patients (Before the 5 weeks of lock down) (After the 5 weeks of lock down)	0.66 0.62
5	Vu et al.	2020	Vietnam	Non-representative sample of Vietnam adult papulation	No	01/04/2020-30/05/2020	EQ-5D-5L	406	Overall	0.95
6	Arab-Zozani et al.	2020	Iran	COVID-19 patients who had been discharged from the Shahid Sadoughi hospital	Covid infection	03/2020	EQ-5D-5L	409	Overall	0.6125

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
7	Azizi et al.	2020	Morocco	Non-representative sample in Moroccan Arabic dialect during the home confinement period	No	09/05/2020-30/05/2020	EQ-5D-5L	573	Overall participants (Before confinement) (During confinement)	0.91 0.86
8	Lim et al.	2020	Singapore	Age at least 21 years old adult Asian outpatients in National University Hospital of Singapore who were known with CVD and had completed a HRQoL questionnaire prior to the COVID-19 outbreak,	No (cardiovascular disease)	29/04/2020-19/06/2020	EQ-5D-3L	81	Overall (Pre-pandemic visit)	0.898
9	Meys et al.	2020	Belgium, Netherlands	Flemish patients with confirmed/suspected COVID-19 were recruited from Belgian social support group on Facebook	Covid (or suspected) infection	06/06/2020	EQ-5D-5L	210	Overall	0.62
10	Ungureanu et al.	2020	Romania	Resident or young specialist working in the gastroenterology department, recruited from 9 public hospitals of major university centers	No	21/04/2020-09/05/2020	15D	96	--	--
11	Than et al.	2020	Vietnam	Frontline HCWs working at the NHTD and the Center for Tropical Diseases (CTD) of Bach Mai Hospital (BMH)	No	03/2020-04/2020	EQ-5D-5L	173	Overall	0.93
12	Guo et al.	2020	China	Chinese patients with skin diseases during COVID-19	No (skin disease)	15/04/2020-27/04/2020	EQ-5D-3L	506	--	--
13	Ferreira et al.	2020	Portugal	Non-representative sample of Portugal's adult population	No	03/2020-05/2020	EQ-5D-5L	904	Overall (Under COVID-19 Quarantine)	0.861

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
									(Pre-covid-19 Pandemic)	0.887
14	Hay et al.	2020	the USA	non representative samples of Amazon MTurk workers in the USA	No	2020	EQ-5D-5L	2764	--	--
15	Alinia et al.	2020	Iran	COVID-19 patients who were discharged from three hospitals over the past (research period) 2 weeks in Iran	Covid infection	21/05/2020-18/06/2020	TTO	287	Overall	0.863
16	van Rüth et al.	2020	Germany	Homeless persons of Hamburg in specialized medical practices or lodging houses,	No	25/05/2020-03/06/2020	EQ-5D-5L	111	Overall (Homeless people)	0.84
17	Gamberini et al.	2020	Italy, Finland	Adults' patients from 16 Italian ICUs infected with COVID-19 due to respiratory failure and the need for invasive mechanical ventilation during ICU stay	Covid infection	22/02/2020-04/05/2020	15D	205	Overall (Study population)	0.85
18	Turcu-Stiolica et al.	2020	Romania, Bulgaria	Pharmacists working in community pharmacies who were with possible contacted with COVID-19 patients from Romania and Bulgaria	No	15/07/2020-15/08/2020	15D	395	Overall (Romania)	0.956
19	Clement et al.	2020	UK	Ten orthopedic departments in the UK of patients on the NHS waiting lists for either a total hip (THA) or total (TKA) or partial knee arthroplasty (PKA) during the months of August and September 2020	No (Total hip (THA) or knee arthroplasty (KA)or partial knee arthroplasty (PKA))	08/2020-09/2020	EQ-5D-5L	843	--	--

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
20	Bäuerle et al.	2020	Germany	Non-representative sample of the German adult population	No	10/03/2020-05/05/2020	EQ-5D-3L	15037	Overall (Before COVID-19 outbreak)	0.8232
21	Szab**ó** et al.	2020	Hungary	non representative sample inside the three public online groups of Hungary adult population	No	07/05/2020-20/05/2020	VAS	431	Overall (Before eliminated the significant outliers) (After eliminated the significant outliers)	0.731 0.751
22	Musche et al.	2020	Germany	Adults' cancer patients of the University Hospital Essen	No (Cancer)	16/03/2020-31/03/2020	EQ-5D-3L	300	Overall (Cancer patients) (Healthy controls)	0.6605 0.7899
23	Beisani et al.	2020	Spain	Patients in the bariatric surgery waiting list of an institution before Lockdown.	No (Bariatric surgery)	05/05/2020-10/05/2020	EQ-5D-5L	51	Overall (Self-rated health index (before LD)) (Self-rated health index (After LD))	0.69 0.64
24	Walle-Hansen et al.	2020	Norway	Covid-19 patients aged over 60 years that were still alive 180 days after hospital admission	Covid infection	01/03/2020-01/07/2020	EQ-5D-5L	106	Overall (Before admission) (After six months)	0.77 0.658
25	Greenhawt et al.	2020	the USA	Non-representative sample of the USA adult population	No	04/25/2020-	EQ-5D-3L	4855	Overall (Surveyed population)	0.714 0.8

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
						06/05/2020			(Normative population total)	
						01/04/2020-			Overall (Pre-COVID-19)	
26	Navarro et al.	2020	Mexico	Patients infected by COVID-19 from a single hospital in Mexico	Covid infection	30/07/2020	EQ-5D-5L	115	(After COVID-19)	0.95 0.85
				Participants who recovered from COVID-19 that from two Facebook		04/06/2020-				
27	Machado et al.	2020	Netherlands, Belgium	groups also who were registered at a website of the Lung Foundation Netherlands	Covid infection	11/06/2020	EQ-5D-5L	1939	--	--
						16/03/2020-			Overall (3 months following discharge)	
28	Todt et al.	2020	Brazil	Adults' patients infected by COVID-19 and survived to hospital discharge	Covid infection	08/05/2020	EQ-5D-3L	251	(Before the onset of COVID-19 symptoms)	0.80121
29	Iqbal et al.	2020	Pakistan	Adult patients from Laboratory recovered from COVID-19	Covid infection	09/2020-12/2020	EQ-5D-5L	158	Overall	0.7076
30	Giusiano et al.	2021	Italy	ALS patients were at the Turin ALS Center and were scheduled from 1st March 2020 to 1st April 2020	No (Amyotrophic lateral sclerosis)	04/2020	EQ-5D-5L	119	--	--
						02/05/2020-				
31	Douglas	2021	UK	HCWs in a university neurosciences center	No	07/06/2020	EQ-5D-3L	215	Total	0.821
32	Zhou et al.	2022	Portland	women at each gestational age between 24 and 32weeks who were hospitalized with PPROM and found to be COVID-19 positive.	Covid infection	NR	EQ-5D-5L	10,000	--	--

N	Author	Year	Country	Sample characteristic	Morbidity	Data collection period	Utility measurement tool	Sample size	Health state utility 1 health state description	Health state utility 1 Mean
33	Xu et al.	2022	China	non representative Chinese adult	No	20/02/2020 - 12/03/2020	EQ-5D-5L	1245	Overall	0.91
34	Wong et al.	2022	China	employees in workplace in Hong Kong, China	No	17/02/2020 - 27/02/2020	EQ-5D-5L	1048	Overall	0.897
35	Şahan et al.	2022	the USA	Patients with a history of COVID-19 diagnosis and persistent OD were recruited from a tertiary medical center and a social media support forum for chemosensory dysfunction.	Covid infection (COVID-19 olfactory dysfunction (OD))	06/2020 and 04/2021	EQ-5D-5L	286	Overall	0.809
36	Russo et al.	2022	Spanish	non representative participants from Madrid	Covid infection	16/02/2021 and 16/04/2021	EQ-5D-5L	125	Overall	0.799
37	Ohsfeldt et al.	2022	Japan	The participants were over 65 years of age and lived in Kakeya, Matsukasa, Tane, or Tai.	No	02/2021 and 02/2022	EQ-5D-5L	38,882	--	--

Table 5 Summary of the heterogeneity in the design of HRQoL literature

Study characteristics	Summary
Geographical location	Europe n=20, North America n=4, Asia n=11, South America n=1, Africa n=1
COVID-19 infection	All participants infected n=13, Participants partly infected n=1, Post COVID patients n=7, Not reported n=16
Morbidity	No specific disease n=16, COVID-19 infection n=14, Alzheimer's disease (AD) and amnesic mild cognitive impairment (MCI) n=1, Cardiovascular disease n=1, Skin disease n=1, Total hip (THA) or knee arthroplasty (KA) or partial knee arthroplasty (PKA) n=1, Cancer n=1, Bariatric surgery n=1, Amyotrophic lateral sclerosis n=1
Study setting	Cross-sectional n=31, Retrospective cohort n=1, Prospective cohort n=1, Cohort study n=2, Decision-analytic model n=1, Longitudinal design n=1
Data collection method	Online questionnaire n=20, Paper questionnaire n=6, Telephone interview(questionnaire) n=8, Personal interview n=3, Patient's medical records n=3 Some of the publication used more than one data collection method
Utility measurement	Direct n=2, Indirect n=35
Tools for direct / indirect utility measurement	VAS n=1, TTO n=1, EQ-5D-3L n=8, EQ-5D-5L n=24, 15D n=3

3.2.2 HRQoL Based on EQ-5D Dimension Responses

In the review, sixteen out of 37 studies used EQ-5D instrument for HRQoL domain assessment. Twelve studies utilized the EQ-5D-5L instrument, known for its validity and reliability across five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, to report HRQoL domain performance. Each

dimension in the EQ-5D-5L has five levels: no problems, slight problems, moderate problems, severe problems, and extreme problems. The EQ-5D-3L, similar to the EQ-5D-5L, assesses the same dimensions but with three levels: no problems, some problems, and extreme problems. Four studies in this review used the EQ-5D-3L instrument for HRQoL domain performance.

Analysis of the studies using EQ-5D instrument identified that the self-care domain (14 studies) was consistently reported as the least affected HRQoL domain, with only two studies indicating usual activities as the least affected domain. Conversely, the anxiety/depression domain was the most affected in eight studies, followed closely by the pain/discomfort domain in seven studies. Mobility and usual activities were also noted as significantly impacted domains. These findings underscore the varied impact of COVID-19 on different HRQoL domains. Detailed outcomes each HRQoL domain assessment are cataloged in Table 6.

Table 6 EO-5D dimensions of HRQoL assessment

First author last name	Year of publication	Most affected dimension	Least affected dimension
Halpin et al.	2020	ICU: Usual activities, Ward: Mobility	ICU + Ward: Self-care
Ping et al.	2020	Pain/discomfort	Self-care
Vu et al.	2020	Anxiety/depression	Self-care
Arab-Zozani et al.	2020	Mobility	Self-care
Azizi et al.	2020	ICU: Pain/discomfort Ward: Anxiety/depression	ICU + Ward: Self-care
Lim et al.	2020	Anxiety/depression	Self-care
Meys et al.	2020	Pain/discomfort	Self-care
Than et al.	2020	Anxiety/depression	Self-care
Ferreira et al.	2020	Anxiety /depression.	Self-care
van Rüth et al.	2020	Pain/discomfort	Self-care
Beisani et al.	2020	Anxiety/depression	Self-care
Greenhawt et al.	2020	Anxiety/depression	Self-care
Navarro et al.	2020	Pain/discomfort	Self-care
Todt et al.	2020	Pain/discomfort	Self-care
Iqbal et al.	2020	Pain/discomfort	Usual activities
Wong, E. L et al.	2022	Anxiety/depression	Usual activities

3.2.3 Analyzing HRQoL Utility Variations Across COVID-19 Infection and Demographics of Selected Literature: An Analysis of Diverse Populations and Methodologies

From the data of 46,709 respondents, we determined 274 health state utilities values (HSUVs). Notably, four studies (Bauerle *et al.*, 2020, Lim *et al.*, 2020, Ordinola Navarro *et al.*, 2021, Ferreira *et al.*, 2021a) provided comprehensive utilities before and after the COVID-19 pandemic, with HSUVs ranging from 0.823 to 0.95 before the pandemic and 0.802 to 0.861 after. Additionally, HSUVs data were richly detailed across studies, including six studies focusing on population norms (Alinia *et al.*, 2021, Azizi *et al.*, 2020, Guo *et al.*, 2020, Hay *et al.*, 2021, Ping *et al.*, 2020, van Ruth *et al.*, 2021). Two articles reported the HSUVs of caregivers before and after lockdown (0.29 to 0.74; 0.31 to 0.72, respectively) and the patient (with HSUVs ranging from 0.5 to 0.66 and 0.6 to 0.62, respectively) (Beisani *et al.*, 2021, Giusiano *et al.*, 2021). Three studies reported the utility of ICU and ward participants during hospitalization with HSUVs ranging from 0.581 to 0.82, and from 0.72 to 0.86, respectively) (Arab-Zozani *et al.*, 2020, Garrigues *et al.*, 2020, Halpin *et al.*, 2021). Three studies reported HSUVs in quarantined individuals (Azizi *et al.*, 2020, Guo *et al.*, 2020, Vu *et al.*, 2020), with HSUVs ranging from 0.86 to 0.96. These findings, summarized in Table 4, underscore the extensive HRQoL challenges posed by the pandemic and highlight the diverse methodologies and populations involved in the current research.

The pandemic's uniform risk of infection contrasted with varying HSUVs across different timeframes and locations. Before the outbreak, higher HSUVs were consistently reported. For example, in Germany, respondents reported a utility of 0.823 before COVID-19, which decreased to 0.803 after the pandemic (Bauerle *et al.*, 2020). Similarly, in Mexico, respondents' utility was 0.95 before the pandemic and 0.85 after (Ordinola Navarro *et al.*, 2021). Similar trends were noted in Morocco and Portugal, with pre-restrictions HSUVs at 0.91 and 0.887 dropping to 0.86 and 0.861 post-restriction (Azizi *et al.*, 2020, Ferreira *et al.*, 2021a). Young specialists in designated COVID-19 hospitals had lower utility values than their counterparts. In Romania, individuals in designated hospitals had a utility of 0.957, compared to 0.966 for those in non-COVID-19 hospitals (Ungureanu *et al.*, 2020). In Vietnam, the utility of participants in designated hospitals was 0.87 compared with 0.93 for non-

designated hospitals (Manh Than *et al.*, 2020). Additionally, examining HSUVs in individuals with and without prior COVID-19 infections revealed nuanced insights into the pandemic's impact on HRQoL across different geographies. Iran reported the highest overall HSUV among previously infected individuals, with a value of 0.863 (Alinia *et al.*, 2021). Conversely, the lowest HSUV, at 0.51, was noted in Belgium and the Netherlands among infected individuals with coexisting health conditions (Meys *et al.*, 2020) (Table 4 and Appendix Table 2).

Among the 37 included studies, 16 identified various determinants associated with diminished HRQoL during COVID-19. Notably, eight studies reported that older individuals tend to experience lower HRQoL levels. Similarly, seven studies identified a correlation between female gender and reduced HRQoL. COVID-19-related factors, such as history of infection, quarantine status, ICU admission, prolonged mechanical ventilation, or longer ICU stay, were linked to decreased HRQoL in five studies. Furthermore, seven studies demonstrated that individuals with comorbidities reported lower HRQoL compared to those without, indicating the compounded impact of additional health challenges. Detailed associations between these factors and HRQoL are systematically presented in Table 7.

Table 7 Key factors contributing to Low HRQoL in selected literature

Author	Year of publication	Factors of low HRQoL detail
Ping et al.	2020	Older age, Unemployed, with chronic disease, low family income, worry about got COVID-19, and have epidemic effects
Vu et al.	2020	Higher ages, females, and living with chronic diseases, working individuals having to be under self-isolation or in government quarantine facilities
Arab-Zozani et al.	2020	Female gender, older age, higher education level, being unemployed, ICU admission, and having diabetes
Than et al.	2020	≥30 years old, had higher working years, had higher incomes, and had mental health and sleep problems, suffered from mental health problems, and sleeping disorders symptoms
Guo et al.	2020	Outdoor activity restriction, loss of income, unemployment
Ferreira et al.	2020	Women, older age categories, low levels of education, single individuals, individuals with chronic diseases
Hay et al.	2020	'Other' gendered persons, Asian, American Indian, or Alaska Native race, Hispanic ethnicity, single, annual incomes less than $20,000, Living alone, experiencing COVID-19-like symptoms not requiring hospitalization, and having a family member diagnosed with COVID-19, self-reported fear of COVID-19's impact on personal health
van Rüth et al.	2020	Higher age and lower education levels
Gamberini et al.	2020	Female sex, increasing age, number of comorbidities, ARDS class, duration of mechanical ventilation, and inability to return to work
Clement et al.	2020	Each additional month spent on the waiting list, and each additional six months on the waiting list patients, younger age, female sex, patients waiting for a THA
Szab**ó** et al.	2020	Perceived stress, level of anxiety, level of depression, number of neurotic complaints, and emotion-focused coping
Walle-Hansen et al.	2020	Older age
Todt et al.	2020	Female sex and intensive care requirement
Xu, Z et al.	2022	living alone
Wong, E et al.	2022	Lack of workplace policies, lack of protective equipment supplies and dissatisfied with workplace policies
Şahan, S et al.	2022	Women, reported having fatigue, shortness of breath, 'brain fog'/confusion, and muscle ache/joint pain, a history of depression and anxiety, sought medical care for their chemosensory dysfunction, belonging to a social media support group for OD, seeing an MD for OD, a history of chronic pain, and depression/anxiety

3.3 Quality Assessment of Selected Studies of HRQoL Literature

Overall, we used the Appraisal Tool for Cross-Sectional Studies (AXIS) (N=31) (Downes *et al.*, 2016), Newcastle-Ottawa Scale (NOS) (N=5) (Sanderson *et al.*, 2007), and Consolidated Health Economic Evaluation Reporting Standards (CHEERS) (N=1)

(Husereau *et al.*, 2022) to assess the quality of selected studies in the HRQoL literature review for cross-sectional studies, cohort studies and decision-analytic model, respectively.

The AXIS tool specifically assesses various aspects of study quality, including the clarity of objectives, appropriateness of study design, sample size justification, representativeness of the sample, measurement validity, and consideration of potential biases. The quality of the cross-sectional studies included in the systematic review was evaluated using the AXIS tool. Responses were recorded as 'Yes' or 'No' to indicate whether specific criteria were met by each study. The results of the quality assessment of 31 eligible studies using the AXIS tool are presented in Appendix Table 3. Our analysis found that all 31 publications had clear study objectives focused on investigating various aspects of HRQoL in populations affected by the COVID-19 pandemic. All studies employed appropriate cross-sectional survey methodologies related to their objectives. Five studies (Bauerle *et al.*, 2020, Hay *et al.*, 2021, Iqbal *et al.*, 2021, Machado *et al.*, 2021, Turcu-Stiolica *et al.*, 2021) reported sample size estimations using justified statistical methods. All studies clearly defined the reference population and sample frame, with selection processes that were generally representative. Additionally, all studies tested both the validity and reliability of their questionnaire, with only one study not providing the statistical significance of key variables (Halpin *et al.*, 2021). Only one study reported an insufficiently described method that was difficult to replicate (Halpin *et al.*, 2021). In reporting survey results, almost all studies presented adequate basic data and addressed concerns about non-response bias. Fifteen studies reported information about non-responders (Arab-Zozani *et al.*, 2020, Azizi *et al.*, 2020, Bauerle *et al.*, 2020, Garrigues *et al.*, 2020, Halpin *et al.*, 2021, Lara *et al.*, 2020, Machado *et al.*, 2021, Meys *et al.*, 2020, Musche *et al.*, 2020, Ping *et al.*, 2020, Szabo *et al.*, 2020, Todt *et al.*, 2021, Vu *et al.*, 2020, Wong *et al.*, 2022, Xu *et al.*, 2022). The results in all studies were internally consistent, and the analyses described in methods were presented. Discussions and conclusions were justified in all studies, with limitations were transparently discussed. Most studies declared no conflicts of interest, with a few exceptions (Meys *et al.*, 2020, Ungureanu *et al.*, 2020), ensuring transparency about potential biases. Ethical approval or consent was obtained in all studies, reflecting adherence to ethical research standards. In general, the evaluated studies met most key criteria for rigorous research. However, notable areas for improvement included justification of sample sizes,

measures for non-responders, and detailed information about non-responders. The consistent use of validated instruments and clear descriptions of target populations and methods were strengths in most studies. Discussions and conclusions were typically well-justified, and limitations were often acknowledged, contributing to the transparency and reliability of the findings. Overall, the quality assessment of 31 studies on the impact of COVID-19 on HRQoL using the AXIS tool reveals a generally high level of methodological rigor, despite some limitations. These studies provide valuable insights into the diverse effects of the pandemic on different populations, significantly contributing to our understanding of HRQoL during COVID-19.The quality of the five included studies was assessed using the NOS (N=5) tool. This tool evaluates studies based on three domains: selection, comparability, and outcome. Each study was assigned stars based on how well they met the criteria in each domain, with a maximum of nine stars indicating the highest quality (Appendix Table 4). All studies effectively selected their exposed cohorts, ensuring representation of their specific populations. For instance, Ryuichi Ohta et al. (Ohta *et al.*, 2022) focused on rural older adults over 65, while M. M. Walle-Hansen et al. (Walle-Hansen *et al.*, 2021) included patients aged 60 and older who were hospitalized due to COVID-19. Beatriz Costa Todt et al. (Todt *et al.*, 2021) studied COVID-19 survivors, Shir Lynn Lim et al. (Lim *et al.*, 2020) examined patients with cardiovascular disease (CVD) in a multi-ethnic Asian population, and Lorenzo Gamberini et al. (Gamberini *et al.*, 2021) focused on critically ill COVID-19 patients from Italian ICUs. Only Ryuichi Ohta and Lorenzo Gamberini (Ohta *et al.*, 2022, Gamberini *et al.*, 2021) included non-exposed cohorts for comparison, whereas the other studies focused solely on exposed individuals. All studies confirmed COVID-19 diagnosis and health outcomes through medical records or validated questionnaires like EQ-5D, ensuring that the outcome of interest was not present at the start of the study, thereby clarifying baseline health status. In terms of comparability, all studies adjusted for key covariates such as age, sex, and other relevant factors, enhancing the reliability of their findings. For example, Ryuichi Ohta, M. M. Walle-Hansen, Beatriz Costa Todt, Shir Lynn Lim, and Lorenzo Gamberini (Gamberini *et al.*, 2021, Lim *et al.*, 2020, Ohta *et al.*, 2022, Todt *et al.*, 2021, Walle-Hansen *et al.*, 2021) received two stars for comparability, indicating robust adjustment methods. The follow-up periods ranged from three months to one year. All studies ensured these periods were long enough to observe outcomes, maintaining high follow-up rates with clear

documentation of missing data. Outcomes were assessed using validated instruments such as the EQ-5D-5L and 15D, ensuring consistent and reliable measurement of HRQoL. Ryuichi Ohta and Shir Lynn Lim (Lim *et al.*, 2020, Ohta *et al.*, 2022) received eight stars each, indicating high-quality studies with comprehensive selection, comparability, and outcome assessment. M. M. Walle-Hansen and Beatriz Costa Todt (Todt *et al.*, 2021, Walle-Hansen *et al.*, 2021) received seven stars each, reflecting strong methodologies but lacking a non-exposed cohort. Lorenzo Gamberini (Gamberini *et al.*, 2021) received nine stars, indicating a very high-quality study with thorough selection and robust follow-up procedures. Collectively, these studies highlight the importance of clear cohort selection, adjustment for key variables, and the use of validated tools in assessing the impact of COVID-19 on HRQoL. They underscore the diverse impacts of COVID-19 across different populations.

One selected study (Sacristán-Galisteo *et al.*, 2022) was assessed using the CHEERS tool (N=1) and received high marks in all areas. The title and abstract were clear and informative, and the background and objectives were well-articulated. The target population and subgroups were appropriately defined, and the setting and location details were provided. The study perspective and comparators were relevant and well-explained, with an adequate time horizon. Health outcomes were clearly chosen, and effectiveness was measured using validated tools like the PCFS scale and EQ-5D-5L. Although resources and cost estimation were not applicable, the assumptions and analytic methods were appropriate and well-explained. The study parameters were well-defined, and uncertainty was characterized through robust statistical analysis. Heterogeneity was addressed by examining various subgroups. Findings, limitations, and generalizability were well discussed, and the source of funding was clearly stated. Overall, the study adhered to CHEERS guidelines, indicating high quality in the assessment of the Spanish version of the PCFS scale (Appendix Table 5).

3.4 Discussion of Findings from This HRQoL Literature Review

This systematic review aimed to explore the relationship between demographic, socio-economic, and COVID-19-related characteristics and HRQoL during the pandemic. The review provides a comprehensive overview of how COVID-19 infection, severity of infection, quarantine measures, vaccination status, and socio-demographic factors influenced HRQoL, along with the performance of the EQ-5D domains in assessing these impacts. Specifically, studies indicated that individuals who were infected with COVID-19, experienced COVID-19 symptoms, or were

hospitalized reported significantly lower HRQoL scores compared to those who did not contract the virus or had mild symptoms (Arab-Zozani *et al.*, 2020, Bauerle *et al.*, 2020, Ferreira *et al.*, 2021a, Garrigues *et al.*, 2020, Guo *et al.*, 2020, Halpin *et al.*, 2021, Iqbal *et al.*, 2021, Machado *et al.*, 2021, Ordinola Navarro *et al.*, 2021, Ping *et al.*, 2020, Vu *et al.*, 2020, Wong *et al.*, 2022). Studies reported that quarantine and isolation measures, while necessary to control the spread of the virus, had a notable negative impact on HRQoL. Increased levels of anxiety, depression, and stress were observed among quarantined individuals, leading to lower HRQoL scores (Azizi *et al.*, 2020, Bauerle *et al.*, 2020, Ping *et al.*, 2020). Vaccination status positively influenced HRQoL, with vaccinated individuals reporting better HRQoL scores compared to non-vaccinated individuals (Arab-Zozani *et al.*, 2020, Ferreira *et al.*, 2021a, Garrigues *et al.*, 2020, Guo *et al.*, 2020, Vu *et al.*, 2020, Wong *et al.*, 2022). The studies provide insights into the performance of the EQ-5D-5L domains (Arab-Zozani *et al.*, 2020, Azizi *et al.*, 2020, Garrigues *et al.*, 2020, Guo *et al.*, 2020, Halpin *et al.*, 2021, Iqbal *et al.*, 2021, Meys *et al.*, 2020, Ordinola Navarro *et al.*, 2021, Ping *et al.*, 2020, Sacristán-Galisteo *et al.*, 2022, Todt *et al.*, 2021, Wong *et al.*, 2022). The findings emphasize the multifaceted impact of COVID-19 on HRQoL and highlight the importance of considering socio-demographic factors when assessing the HRQoL of populations during COVID-19 (Arab-Zozani *et al.*, 2020, Azizi *et al.*, 2020, Bauerle *et al.*, 2020, Ferreira *et al.*, 2021a, Guo *et al.*, 2020, Halpin *et al.*, 2021, Ordinola Navarro *et al.*, 2021, Ping *et al.*, 2020, Sacristán-Galisteo *et al.*, 2022, Said *et al.*, 2022, Vu *et al.*, 2020, Wong *et al.*, 2022, Xu *et al.*, 2022).

The reviewed studies collectively highlight the extensive and persistent symptoms experienced by COVID-19 survivors. COVID-19 infection, particularly when accompanied by severe symptoms, significantly decreased the HRQoL of participants, emphasizing the need for comprehensive post-recovery rehabilitation programs (Halpin *et al.*, 2021, Garrigues *et al.*, 2020, Ordinola Navarro *et al.*, 2021, Said *et al.*, 2022, Sacristán-Galisteo *et al.*, 2022, Azizi *et al.*, 2020, Iqbal *et al.*, 2021).

Quarantine measures and isolation further contribute to the decline in HRQoL, as noted by Arab-Zozani et al. (Arab-Zozani *et al.*, 2020). The mental health burden of being isolated, the disruption of daily routines, and the uncertainty about health outcomes can significantly diminish HRQoL. The restrictions imposed during quarantine can lead to reduced physical activity, altered eating habits, and changes in sleep patterns, all of which negatively affect physical and mental well-being.

Vaccination status is another critical factor influencing HRQoL. Unvaccinated individuals reported lower HRQoL due to ongoing health concerns and heightened anxiety about contracting the virus, as observed by Alinia et al., Zhang et al., and Ferreira et al. (Alinia *et al.*, 2021, Xu *et al.*, 2022, Ferreira *et al.*, 2021a). The sense of vulnerability and fear of severe illness among unvaccinated individuals can lead to increased stress and anxiety, further reducing HRQoL. In contrast, vaccinated individuals generally reported better HRQoL, likely due to the perceived protection against severe disease and reduced anxiety about COVID-19. The use of the EQ-5D instrument in these studies consistently showed significant drops in HRQoL, particularly in domains such as pain/discomfort and anxiety/depression (Halpin *et al.*, 2021, Ping *et al.*, 2020, Vu *et al.*, 2020, Ordinola Navarro *et al.*, 2021, Said *et al.*, 2022).

The COVID-19 pandemic has highlighted the critical role of sociodemographic determinants in shaping HRQoL. Age, gender, education, employment status, marital status, and income significantly influence how individuals experience and cope with the pandemic. Targeted public health strategies and support systems addressing these determinants are essential to mitigate the adverse impacts of the pandemic on HRQoL. Studies consistently indicate that older adults report lower HRQoL compared to younger individuals. This association is evident in the increased mobility and self-care problems among older populations, as well as the exacerbation of chronic conditions that further diminish HRQoL (Ferreira *et al.*, 2021a)(Arab-Zozani *et al.*, 2020)(van Ruth *et al.*, 2021). Gender disparities have also been highlighted, with females reporting lower HRQoL and higher levels of anxiety and depression compared to males. The increased burden of multitasking, such as managing household responsibilities and supporting family members during lockdown, has been identified as a significant stressor contributing to these differences. This trend was evident in multiple studies, including those by Ferreira et al., Nguyen et al., and Arab-Zozani et al., which attributed lower HRQoL in women to higher anxiety levels and the additional burden of domestic responsibilities and caregiving roles during lockdowns (Arab-Zozani *et al.*, 2020, Ferreira *et al.*, 2021a, van Ruth *et al.*, 2021). However, Van Rüth et al. did not find significant associations between HRQoL and gender within the homeless population, possibly due to the uniformity of environmental conditions faced by homeless men and women (van Ruth *et al.*, 2021). Marital status influences HRQoL, with single, divorced, or widowed individuals tending to experience higher anxiety

and lower HRQoL. These individuals often face increased feelings of loneliness and isolation during quarantine periods, exacerbating their mental health challenges. Widowed individuals, in particular, have been shown to have the lowest HRQoL scores among all marital status categories (Azizi *et al.*, 2020, Ferreira *et al.*, 2021a, Hay *et al.*, 2021). These findings underscore the importance of social support systems in mitigating the adverse impacts of the pandemic on HRQoL. Higher education levels were associated with better HRQoL. Educated individuals tend to have better access to information and resources, enabling them to cope more effectively with the challenges of the pandemic. Employment status also plays a critical role, with unemployed individuals reporting lower HRQoL. The stability and social interactions provided by employment significantly contribute to better mental and physical health (Arab-Zozani *et al.*, 2020, Ferreira *et al.*, 2021a). The job losses caused by the pandemic exacerbated stress and anxiety levels among the unemployed, as also highlighted in the studies by Hay et al. (Hay *et al.*, 2021). Economic factors, including income level and financial stability, are crucial determinants of HRQoL. Higher income levels are consistently associated with better HRQoL, as financial resources enable access to healthcare, nutritious food, and a comfortable living environment. Conversely, financial strain during the pandemic has been linked to lower HRQoL. Studies by Hay et al. and Ferreira et al confirmed that increased income correlated with higher HRQoL scores during the pandemic (Ferreira *et al.*, 2021a, Hay *et al.*, 2021).

Strengths and Limitations

The strengths of this systematic review include a comprehensive search strategy and the inclusion of diverse study populations, providing a broad understanding of socio-determinants of HRQoL during the COVID-19. Additionally, the review considered both physical and psychological health, offering a holistic view of HRQoL. The high response rate ensures that the findings are representative of the staff at the institution (Douglas *et al.*, 2021). However, several limitations must be acknowledged. Heterogeneity among studies in terms of methodologies and populations can introduce biases and affect the generalizability of the findings. Additionally, the reliance on self-reported measures in many studies may lead to underreporting or overreporting of symptoms and HRQoL impacts. The cross-sectional design provides participants' HRQoL at a single point in time, limiting the ability to infer causality or track changes

over time. The voluntary nature of the survey may have led to response bias, with those experiencing higher levels of burnout being more likely to participate.

3.5 Conclusion

In conclusion, this systematic review highlights the significant and multifaceted impact of COVID-19 on HRQoL. The persistence of physical and psychological symptoms underscores the need for comprehensive long-term support for survivors. Addressing socio-demographic disparities and implementing robust mental health interventions will be essential for promoting resilience and improving HRQoL in the post-pandemic era.

4 Empirical Research on Health-Related Quality of Life and Life Satisfaction Among the General Hungarian Population During the COVID-19 Pandemic

The analyses presented in this chapter have resulted in two prepared publications. One has been accepted for publication in the Q3 journal Mental Health and Social Inclusion, and the other is currently undergoing peer review. These publications provide comprehensive detail regarding the findings from the two case studies, thereby contributing to the scholarly understanding of HRQoL and subjective well-being during the ongoing pandemic.

4.1 Hypothesis and Objective

In this dissertation, we conducted a comprehensive analysis of how socio-demographic factors and COVID-19-related experiences affect Health-Related Quality of Life (HRQoL) and life satisfaction during the pandemic. The first study explores the determinants of HRQoL as measured by the EQ-5D-5L utility index and its five domains. The second study focuses on assessing the impact of these determinants on Subjective Well-Being (SWB), particularly life satisfaction, anxiety, and depression. Both studies draw data from the same questionnaire survey. This two-case approach was used to thoroughly investigate the broad spectrum of HRQoL and SWB during the COVID-19 pandemic, guided by a set of hypotheses and objectives established before the study.

4.1.1 Hypothesis

Hypothesis 1: Individuals who have had COVID-19, especially those with severe symptoms or hospitalizations, will report lower HRQoL compared to those who have not been infected.

Hypothesis 2: COVID-19 infection status will influence the reporting of problems in all EQ-5D-5L dimensions, with previously infected individuals being more likely to report problems in dimensions such as mobility and usual activities due to the lingering effects of the virus on physical health.

Hypothesis 3: Older age groups are expected to report more problems across all dimensions of HRQoL compared to younger age groups, reflecting the impact of aging on physical health. Additionally, gender differences are expected. This assumed that age and gender may have significant and distinct effects on HRQoL during the COVID-19 pandemic.

Hypothesis 4: Socioeconomic factors have a significant impact on HRQoL during the COVID-19 pandemic, we assumed that with higher socioeconomic status being associated with better HRQoL.

Hypothesis 5: Experiences related to COVID-19, such as severity of infection, quarantine and vaccination status, differentially affect HRQoL. Severe infections, quarantined status and vaccinated status lead to lower HRQoL.

Hypothesis 6: Age, marital status and socioeconomic status (including educational level and net monthly income) significantly influence life satisfaction during the COVID-19 pandemic.

Hypothesis 7: Direct COVID-19 experience (severity of infection, quarantine status, and vaccination status) will significantly affect levels of anxiety and depression. Severe COVID-19 infection, quarantined status and vaccinated status are expected to be associated with increased levels of anxiety and depression.

Hypothesis 8: Direct experiences of COVID-19, such as severity of infection and quarantine, will have nuanced effects on life satisfaction. It is expected that more severe COVID-19 infections and the experience of quarantine will exacerbate the impact on life satisfaction may reveal complex patterns, possibly indicating resilience or adaptation in some individuals.

4.1.2 Objectives

The aim of this dissertation is to systematically investigate the multifaceted impact of the COVID-19 crisis and government responses on HRQoL and SWB in the Hungarian population, addressing the lack of empirical evidence in this context. This endeavor is strongly motivated by the notable lack of population-level research on the mental well-being of Hungarians during the pandemic. Therefore, an in-depth exploration of the determinants underlying vulnerability to HRQoL and SWB fluctuations will be undertaken against the backdrop of the COVID-19 pandemic in Hungary. The findings of this study have significant implications for evidence-based policy formulation and targeted interventions to promote resilience and mitigate the adverse effects of the pandemic in the Hungarian community.

Understanding the impact of COVID-19-related experiences

This study focuses on exploring how COVID-19-related experiences, such as infection, quarantine, vaccination status, and the broader psychological impact of the pandemic, shape individuals' HRQoL and SWB. By examining the direct and indirect effects of these experiences, we aim to elucidate the complex relationship between

pandemic characteristics and HRQoL and life satisfaction. Particular attention will be paid to identifying stressors and protective factors that emerge in the context of COVID-19, with the aim of gaining insight into how these unique dynamics influence individuals' HRQoL and life satisfaction during the pandemic.

Analysis of socio-demographic factors in the context of COVID-19

This dissertation also seeks to assess the role of socio-demographic factors such as age, gender, marital status, education, employment status, and monthly income in influencing the impact of COVID-19 on individuals' HRQoL and SWB in Hungary during the pandemic. By understanding how these demographic factors intersect with pandemic-related characteristics, this dissertation aims to identify vulnerable populations and the specific challenges they face due to COVID-19.

Overall, by focusing on these objectives, the dissertation aims to provide a detailed and actionable understanding of how COVID-19-related characteristics influence HRQoL and SWB of Hungarians during the pandemic. The findings are expected to inform the development of comprehensive support systems and policies that are responsive to the evolving needs of the population during and after the pandemic, ultimately contributing to the promotion of a healthier, more resilient society.

4.2 Introduction of Health-Related Quality of Life and Life Satisfaction and COVID-19

4.2.1 Background and Context of HRQoL and COVID-19

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic (WHO, 2020, March 11). By May 9, 2023, Hungary had reported 2,201,824 cases, 48,849 deaths, and 2,149,292 recoveries (Worldometer, 2023). Governments worldwide, including Hungary's, implemented measures to curb COVID-19 spread and manage its impact. Actions included border shutdowns, travel restrictions, and closures of schools, workplaces, public transport systems, and non-essential businesses. Social distancing and quarantine protocols were also widely enforced (Ufficiale, Organization, 2020a, Trade, 2020). For instance, in March 2020, the Hungarian government enforced a lockdown in response to the COVID-19 pandemic (Hungary, 2020). Additionally, by February 10, 2022, approximately 6,377,000 people, or 66.2% of the Hungarian population, had been vaccinated (Statista, 2022). Recognizing that the prolonged quarantine, ongoing infections, and new vaccines have various consequences, including psychological effects and a reduced HRQoL (Walle-Hansen *et al.*, 2021, Shah *et al.*, 2021).

The EQ-5D, developed by the EuroQol Group, is the most widely used preference-based instrument for measuring and assessing HRQoL. It is used in studies and clinical practices, including clinical trials, patient monitoring, cost-utility analysis (CUA) and population health measurement. Interpretation of the EQ-5D is often facilitated by using population norms or reference scores, especially research during the pandemic. EQ-5D has extensively studied the HRQoL of populations in many countries (König *et al.*, 2023, Tamson *et al.*, 2022, Ping *et al.*, 2020). A study in seven European countries found that the EQ-5D score decreases with increasing age, perceived income difficulties, (un)confirmed COVID-19 infection, perceived health risk from COVID-19, and a higher COVID-19 stringency index (König *et al.*, 2023). In Estonia, declines in mean EQ-5D scores were observed for all socio-demographic and behavioural variables considered. For instance, older age, being unemployed or economically non-active and having financial difficulties were significantly associated with lower HRQoL (Tamson *et al.*, 2022). Older age, unemployed, with chronic disease, low family income, worry about got COVID-19, and have epidemic effects were associated with lower EQ-5D score in the general Chinese population (Ping *et al.*, 2020). Beyond what we have discussed, it is crucial to consider other factors affecting HRQoL during the pandemic, such as COVID-19 severity (Halpin *et al.*, 2021, Garrigues *et al.*, 2020), quarantine status (Ferreira *et al.*, 2021a), vaccination status (Turcu-Stiolica *et al.*, 2021), and the impact of COVID-19-related characteristics on family members' HRQoL (Xu *et al.*, 2022, Shah *et al.*, 2021). Recognizing and addressing these factors collectively in Hungary will help make informed decisions and take appropriate actions.

4.2.2 Background and Context of Life Satisfaction and COVID-19

The COVID-19 pandemic has also had positive effects. Research has shown strengthened familial bonds, new leisure activities (Evans *et al.*, 2020), and improved environmental conditions, such as reduced air pollution, better air and water quality, and decreased noise levels. However, research increasingly highlights the negative impact of the pandemic and control measures, including decreased life satisfaction and increased anxiety, distress, depression, anger, and fear (Le and Nguyen, 2022).

Research during the pandemic indicates that higher life satisfaction influences individuals' SWB (Mehrsafar *et al.*, 2021, Rogowska *et al.*, 2021, Xiao *et al.*, 2021). Factors influencing life satisfaction include age, gender, psychological characteristics, lifestyle choices, and engagement in and satisfaction with leisure activities (Passos *et*

al., 2020, Rogowska *et al.,* 2021). Additionally, COVID-19-related characteristics significantly contribute to life satisfaction (Rogowska *et al.,* 2021, Mehrsafar *et al.,* 2021). Different measures offer various perspectives on individuals' life satisfaction. A common tool, the SWLS, assesses SWB, including life satisfaction, by comparing individuals' hopes and dreams with their actual happiness (Diener *et al.,* 1985). Developed in the United States in 1985, the SWLS has been widely used and validated in many countries (Esnaola *et al.,* 2017, Atienza González *et al.*, 2016, Jovanović, 2016, Clench-Aas *et al.*, 2011). The SWLS shows good convergent validity with other SWB measures and divergent validity for depression, anxiety, and psychological distress (Pavot and Diener, 2008). Short questionnaires are useful for screening symptoms of depression and anxiety. The 9-item Patient Health Questionnaire (PHQ-9) assesses depressive symptoms (Choo *et al.,* 2001), while the 7-item Generalized Anxiety Disorder scale (GAD-7) (Spitzer *et al.,* 2006) assesses anxiety symptoms.

From March 4 to 21, 2021, the Hungarian government implemented its third and final lockdown in preparation for the third wave of the COVID-19 pandemic (Köves, 2021). As discussed, the lockdown adversely affected people's lives. The pandemic has led to decreased life satisfaction and increased stress, fear, anxiety, and depression among Hungarians (Garbóczy *et al.,* 2021, Szabo *et al.,* 2020). Despite this growing concern, few studies have assessed it in Hungary during the pandemic. This gap highlights the need for comprehensive research to understand the full impact of the pandemic on SWB and mental health in Hungary. Our study aims to fill this void by providing detailed insights into the prevalence and intensity of these mental health challenges. This will provide valuable data to policymakers, healthcare providers, and community leaders, enabling them to devise targeted interventions and support mechanisms. Moreover, our research could serve as a basis for future studies, contributing to a deeper understanding of the pandemic's long-term effects on mental well-being.

4.3 Methodology

4.3.1 Data collection

A professional survey company conducted a large cross-sectional online survey between May 25 and June 8, 2021. Participants provided self-reported data on health status using the EQ-5D-5L questionnaire, life satisfaction using SWLS questionnaire, and anxiety using the 7-item Generalized Anxiety Disorder scale (GAD-7), and depression using 9-item Patient Health Questionnaire (PHQ-9) questionnaire. They also responded to questions on demographic, socioeconomic, and COVID-19-related

characteristics. These questions included gender, age, educational level, marital status, monthly income, occupational status, severity of COVID-19 infection, personal and family members' experiences with COVID-19, vaccination status, and quarantine status. Data collection continued until the desired sample size of 2,000 adults aged 18 and over was reached. Permission to conduct the study was granted by the Research Ethics Committee of the Corvinus University of Budapest (reference No. KRH/109/2021). Respondents were informed that participation was completely voluntary, data would remain anonymous, not linked to personal information, and used only for scientific purposes. Respondents gave informed consent before starting the survey.

4.3.2 Questionnaire survey

4.3.2.1 Socio-demographic variables

The following socio-demographic variables were collected : age, gender ('female' and 'male'), marital status ('single', 'married', 'divorced', 'widowed' and 'live in a cohabitation relationship'), education level ('primary education', 'secondary education' and 'university education'), occupational type ('full-time employed', 'part-time employed', 'entrepreneur', 'unemployed', 'student', 'take care of family members', 'retired', 'disabled pensioner', 'inactive looking for a job', and 'other occupational status'), and monthly net income.

4.3.2.2 COVID-19-related Characteristics

The survey tracked COVID-19 related characteristics including previous infection ('Have you been infected with COVID-19?', 'Has anyone in your household been infected with COVID-19?', 'Has a close family member not in the household had a COVID-19 infection?'), severity of COVID-19 infection ('No symptoms were observed', 'Mild symptoms that did not affect daily activities', 'Perceived severe symptoms that limited daily activities (e.g., needed bed rest)', 'Needed hospital care or intensive care unit (ICU) care'), quarantine status ('Have you been quarantined?'), and vaccination status ('Have you been vaccinated against COVID-19?').

4.3.2.3 Description of the EQ-5D-5L Instrument

As described in Section 2.3, the EQ-5D is a standard instrument for measuring HRQoL. For further details on this instrument, please refer to the background section. For each EQ-5D-5L health state, a single utility value can be derived from country-

specific value sets. This study used the Hungarian EQ-5D-5L value set (Rencz *et al.*, 2020).

4.3.2.4 Description of the Satisfaction with Life Scale Instrument

The study used the SWLS developed by Diener et al. (Diener *et al.*, 1985), to measure life satisfaction in the Hungarian population during the COVID-19 pandemic. The SWLS is a valid and reliable tool, widely used in many countries and populations. This study used the Hungarian version of the SWLS (Martos *et al.*, 2014). The instrument's internal consistency and reliability were tested using Cronbach's alpha prior to data collection. The scale consists of 5 items, scored on a seven-point Likert scale (1 'strongly disagree' to 7 'strongly agree'). The respondent's score is the sum of agreement levels with the five statements, ranging from 5 to 35 points (Diener *et al.*, 1985, Martos *et al.*, 2014). Higher scores indicate greater life satisfaction. SWLS scores classify life satisfaction as 5–9, 10-14, 15-19, 20, 21-25, 26-30 and 31-35: Extremely dissatisfied, dissatisfied, slightly dissatisfied, neutral, slightly satisfied, satisfied, and extremely satisfied. Participants with scores of 5-20 were considered dissatisfied with their life (5-20, dissatisfied vs. 21-35, satisfied) in the binary regression analysis (Pavot and Diener, 1993) (Cronbach's $\alpha = 0.898$).

4.3.2.5 Description of the Patient Health Questionnaire Instrument

The 9-item Patient Health Questionnaire (PHQ-9) (Choo *et al.*, 2001) assessed depressive symptoms using a 4-point Likert scale with 9 items (ranging from 0 = not at all to 3 = nearly every day), and ranging from 0-27 score. Higher scores indicate a higher level of depression. PHQ-9 scores (0-4, 5-9, 10-14, 15-19, and 20-27) reflect none/minimal, mild, moderate, moderate-severe, and severe symptoms, respectively. The internal consistency reliability, assessed by Cronbach's alpha, was 0.91(Cronbach's $\alpha = 0.910$). Participants with score of 0-4 were considered to have no symptoms (0-4, no symptoms vs. 5-27, have symptoms) of depression in the binary regression analysis.

4.3.2.6 Description of the Generalized Anxiety Disorder Scale Instrument

Anxiety symptoms were assessed using the 7-item Generalized Anxiety Disorder scale (GAD-7 (Spitzer *et al.*, 2006)), where participants rated how often they had experienced anxiety symptoms in the two weeks prior to the study using a 4-point Likert scale (0 = not at all, 1 = several days, 2 = more than half the days, and 3 = nearly every day). It ranges between 0 and 27 score. Higher scores indicate a higher level of

anxiety. GAD-7 scores (0–4, 5–9, 10–14, and 15– 21) represent minimal, mild, moderate, and severe anxiety levels, respectively. Internal consistency reliability was established (Cronbach's $\alpha = 0.934$). Participants with scores of 0-4 were considered to have no symptoms (0-4, no symptoms vs. 5-21, have symptoms) of anxiety in the binary regression analysis.

4.3.3 Data Analysis

4.3.3.1 Data Analysis for Health-Related Quality of Life

First, descriptive statistics were calculated to analyze general characteristics. Demographic characteristics were described using frequencies and percentages, and EQ-5D-5L utility values were presented as means and standard deviations. Next, the distribution of each EQ-5D-5L dimension was presented by calculating frequencies stratified by respondents' and their family members' previous COVID-19 infection status. Then, both binary regression and linear regression were utilized to analyze the data. Specifically, logistic regression was applied to assess the binary outcomes related to the EQ-5D-5L dimensions. The five dimensions of EQ-5D-5L—mobility, self-care, usual activities, pain/discomfort, and anxiety/depression—were dichotomized into 'no problems' (level 1) and 'any problems' (levels 2-5). Level 1 was coded as 0, and levels 2 to 5 were coded as 1. This dichotomization allowed for the evaluation of how various sociodemographic factors and COVID-19-related variables influenced the likelihood of respondents experiencing difficulties in each dimension. To interpret the logistic regression results more intuitively, we computed marginal effects for each independent variable, which indicate the change in the predicted probability of experiencing the outcome for a one-unit increase in each predictor, while holding other variables constant. Marginal effects provide a more intuitive interpretation compared to odds ratios, particularly when dealing with categorical predictors. The first step involved running the logistic regression models for each dependent variable (e.g., mobility, self-care, usual activities, pain/discomfort and anxiety/depression), using logistic regression with all relevant independent variables. After estimating the logistic regression model, we calculated the marginal effects for all the independent variables (Appendix Table 8). For the continuous outcome, linear regression was employed to analyze the EQ-5D-5L utility score, which serves as a composite measure representing overall health status. This utility score integrates information across all five dimensions of the EQ-5D-5L, providing a single, continuous measure of HRQoL.

Linear regression was chosen for this analysis as it facilitates the examination of how independent variables, such as demographic characteristics and COVID-19-related factors, are associated with variations in the overall EQ-5D-5L utility score. In both types of regression, independent variables were sociodemographic and COVID-19-related characteristics.

Regression diagnostic methods were employed to ensure the validity and reliability of the regression models. For the logistic regression models used to analyze the dichotomous outcomes in the EQ-5D-5L dimensions, goodness-of-fit was evaluated using the Hosmer-Lemeshow test, which is designed to assess how well the model's predicted probabilities align with the observed outcomes. Additionally, model summary provides additional insight into the fit through the -2 Log likelihood and R^2 values. The Cox & Snell and Nagelkerke R^2 values provide estimates of the explained variance in the dependent variable, where higher values signify better explanatory power. These diagnostic methods were crucial in confirming that the regression models were appropriate and that the results were robust and interpretable. For the linear regression analysis of the EQ-5D-5L utility score, diagnostic checks were performed to verify that the assumptions of the linear model were met. Multicollinearity, which occurs when independent variables are highly correlated, was assessed by calculating the Variance Inflation Factor (VIF). A low VIF indicated that multicollinearity was not a concern in the model, ensuring that the estimates of regression coefficients were stable and reliable. A 95% confidence level was defined for all statistical analyses, including both the linear and logistic regression models. This confidence level corresponds to a significance level (alpha) of 0.05, which is standard in social science research.

The equation of logistic (Q1) and linear (Q2) regression:

$$Q1 = \beta_0 + \beta_1 \text{ Age}_{25-34} + \beta_2 \text{ Age}_{35-44} + \beta_3 \text{ Age}_{45-54} + \beta_4 \text{ Age}_{55-64} + \beta_5 \text{ Age}_{65+} + \beta_6 \text{ Gender}_{\text{Male}} + \beta_7 \text{ Education}_{\text{Intermediate}} + \beta_8 \text{ Education}_{\text{Higher}} + \beta_9 \text{ Employment}_{\text{Part-time}} + \beta_{10} \text{ Employment}_{\text{Entrepreneur}} + \beta_{11} \text{ Employment}_{\text{Unemployed}} + \beta_{12} \text{ Employment}_{\text{Student}} + \beta_{13} \text{ Employment}_{\text{Caregiver}} + \beta_{14} \text{ Employment}_{\text{Retired}} + \beta_{15} \text{ Employment}_{\text{Disabled}} + \beta_{16} \text{ Employment}_{\text{Inactive}} + \beta_{17} \text{ Employment}_{\text{Other}} + \beta_{18} \text{ Income}_{900-2571} + \beta_{19} \text{ Income}_{2572+} + \beta_{20} \text{ Income}_{\text{Unknown}} + \beta_{21} \text{ Infected}_{\text{No}} + \beta_{22} \text{ HouseholdInfected}_{No} + \beta_{23} \text{ FamilyInfected}_{No} + \beta_{24} \text{ COVID} - 19 \text{ Severity}_{\text{Mild}} + \beta_{25} \text{ COVID} - 19 \text{ Severity}_{\text{Severe}} + \beta_{26} \text{ COVID} - 19 \text{ Severity}_{\text{Hospitalized}} + \beta_{27} \text{ Quarantined}_{No} + \beta_{28} \text{ Vaccinated}_{No} + \epsilon$$

$$Q2 = \beta_0 + \beta_1 \text{ Age} + \beta_2 \text{ Gender} + \beta_3 \text{ Education} + \beta_4 \text{ Employment} + \beta_5 \text{ Income} + \beta_6 \text{ COVID} - 19 \text{ Infected}_{\text{Self}} + \beta_7 \text{ HouseholdInfected} + \beta_8 \text{ FamilyInfected} + \beta_9 \text{ COVID} - 19 \text{ Severity} + \beta_{10} \text{ Quarantine} + \beta_{11} \text{ Vaccination} + \epsilon$$

4.3.3.2 Data Analysis for Life Satisfaction

In terms of life satisfaction study. Normality was assessed using skewness and kurtosis, with decision rules stating that values < |1| are acceptable for normality (George and Mallery, 2019). Descriptive analysis described general data using frequencies and percentages. Correlation was examined using Pearson correlation coefficients, and differences in mean scores were tested using one-way ANOVA.

Treating SWLS, GAD-7, and PHQ-9 scores as continuous variables, linear regression models provide a detailed understanding of the direct impact each independent variable has on an individual's life satisfaction, anxiety levels, and depressive symptoms. For example, the coefficients from these models indicate how a one-unit change in a particular sociodemographic or COVID-19 related factor is expected to affect the scores of SWLS, GAD-7, and PHQ-9, holding all other variables constant. Diagnostic checks were also performed to verify that the assumptions of the linear model were met and was assessed by calculating the Variance Inflation Factor (VIF). In this study, a 95% confidence level was also defined for statistical analyses. The independent variables included sociodemographic and COVID-19-related variables. Statistical Product and Service Solutions (SPSS) version 23, STATA, and R software were used to create a database and conduct statistical analysis for both studies. The equation of this linear regression:

The equation of this linear regressions:

$$Anxiety/depression/life\ satisfaction\ Scores\ (S) = \beta_0 + \beta_1\ \text{Age} + \beta_2\ \text{Gender} + \beta_3\ \text{Maritalstatus}$$

$$+\beta_4\ \text{Education} + \beta_5\ \text{Employment} + \beta_6\ \text{Income}$$
$$+\beta_7\ \text{COVID} - 19\ \text{Infected Self} + \beta_8\ \text{HouseholdInfected}$$

$$+\beta_9\ \text{FamilyInfected} + \beta_{10}\ \text{COVID} - 19\ \text{Severity} + \beta_{11}\ \text{Quarantine} + \beta_{12}\ \text{Vaccination} + \epsilon$$

4.4 Results

4.4.1 Overview of the Study Sample

Table 8 summarizes the characteristics of the study sample, which comprised 2,000 adults with a slight female majority (1,067 female, 53%), ranging in age from 18 to 86 years. Most respondents were married (40.3%, n = 805), employed full-time (42.3%, n = 845), and had completed primary education (51%, n = 1020), with over half reporting a monthly income below 899 Euros (55.2%, n = 1105). Regarding COVID-19-related characteristics, 351 individuals had previously contracted COVID-19, with an equal distribution across genders. Among them, 128 participants (36.4%) experienced mild symptoms, while 184 (52.3%) reported severe symptoms. Furthermore, 17.1% (n =341) of participants reported that close family members living in the same household, and 36.7% (n =733) in different households, had contracted COVID-19. Additionally, 330 participants (16.5%) had undergone quarantine, and 1,262 (63.1%) had received vaccination, highlighting the COVID-19's significant impact on our sample. This demographic and COVID-19-related profile provides important context for our study's findings.

Table 8 General characteristics of the study sample

Variables	Reference population(%) [a]	Total N (%)	Female N (%)	Male N (%)
Reference population (%) [a]		100[a]	53.1[a]	46.9[a]
Age (years)		2000	1067 (53.35%)	933 (46.64%)
18-24	10.0%	213 (10.6%)	159 (14.9%)	54 (5.8%)
25-34	15.2%	339 (16.9%)	207 (19.4%)	132 (14.1%)

Variables	Reference population(%) [a]	Total N (%)	Female N (%)	Male N (%)
35-44	19.5%	376 (18.8%)	172 (16.1%)	204 (21.8%)
45-54	16.0%	310 (15.5%)	152 (14.2%)	158 (16.9%)
55-64	16.8%	353 (17.6%)	178 (16.7%)	175 (18.7%)
65 +	22.5%	412 (20.6%)	201 (18.8%)	211 (22.6%)
Marital status		1999	1067 (53.35%)	932 (46.64%)
Single		459 (23.0%)	223 (20.9%)	236 (25.3%)
Cohabiting	34.3%[b]	433 (21.7%)	282 (26.4%)	151 (16.2%)
Married	44%	805 (40.3%)	352 (33.0%)	453 (48.6%)
Divorced	10.7%	171 (8.6%)	106 (9.9%)	65 (7%)
Widowed	11%	131 (6.6%)	104 (9.7%)	27 (2.9%)
Education		2000	1067 (53.35%)	933 (46.64%)
Primary school	23.8%	1020 (51.0%)	549 (51.5%)	471 (50.5%)
Intermediate level	55.0%	626 (31.3%)	349 (32.7%)	277 (29.7%)
Higher education	21.2%	354 (17.7%)	169 (15.8%)	185 (19.8%)
Employment		1999	1067 (53.35%)	933 (46.64%)
Employed full-time		845 (42.3%)	366 (34.3%)	479 (51.3%)
Employed part time		131 (6.6%)	80 (7.5%)	51 (5.5%)
Entrepreneur	53.1%[c]	49 (2.5%)	17 (1.6%)	32 (3.4%)
Unemployed	4.7%	112 (5.6%)	73 (6.8%)	39 (4.2%)
Student	3.1%	98 (4.9%)	65 (6.1%)	33 (3.5%)
Takes care of family members	1.0%	122 (6.1%)	118 (11.1%)	4 (0.4%)
Retired	26.1%	505 (25.3%)	259 (24.3%)	246 (26.4%)
Disabled pensioner	3.1%	80 (4.0%)	46 (4.3%)	34 (3.6%)
Inactively seeking employment		29 (1.5%)	21 (2.0%)	8 (0.9%)
Other occupational status	8.9%[d]	28 (1.4%)	21 (2.0%)	7 (0.8%)
Monthly income (Euro) [e]		2000	1067 (53.35%)	933 (46.64%)
Low (0 -899)	N/A	1105 (55.2%)	663 (62.1%)	441 (47.3%)
Middle (900-2571)	N/A	507 (40.8%)	206 (19.3%)	301 (32.3%)
High (2572+)	N/A	26 (1.3%)	12 (1.1%)	14 (1.5%)
I don’t know / I don’t answer	N/A	363 (18.2%)	186 (17.4%)	177 (19.0%)

Variables	Reference population(%) [a]	Total N (%)	Female N (%)	Male N (%)
Have you been infected with COVID-19?		2000	1067 (53.35%)	933 (46.64%)
Yes	N/A	351 (17.6%)	177 (16.6%)	174 (18.6%)
No	N/A	1649 (82.5%)	890 (83.4%)	759 (81.4%)
Has anyone in your household infected with COVID-19?		1999	1067 (53.35%)	933 (46.64%)
Yes	N/A	341 (17.1%)	169 (15.8%)	172 (18.5%)
No	N/A	1658 (82.9%)	898 (84.2%)	760 (81.5%)
Has a close family member not in the household had a COVID-19 infection?		1999	1067 (53.35%)	933 (46.64%)
Yes	N/A	733 (36.7%)	404 (37.9%)	329 (35.3%)
No	N/A	1266 (63.3%)	663 (62.1%)	603 (64.7%)
Severity of COVID-19 infection		351 (17.5%)	177 (50.4%)	174 (59.6%)
No symptoms were observed	N/A	30 (8.5%)	13 (7.3%)	17 (9.8%)
Experienced mild symptoms that did not affect his daily activities	N/A	128 (36.4%)	55 (31.1%)	73 (42.0%)
Perceived severe symptoms that limited his / her daily activities (e.g., needed bed rest)	N/A	184 (52.3%)	102 (57.6%)	82 (47.1%)
Needed hospital care or intensive care unit (ICU) care	N/A	9 (2.6%)	7 (4.0%)	2 (1.1%)
Have infected people been quarantined?		2001	1068 (53.35%)	933 (46.64%)
Yes	N/A	331 (16.5%)	187 (17.5%)	144 (15.4%)
No	N/A	1670 (83.5%)	881 (82.5%)	789 (84.6%)
Have you been vaccinated against COVID-19?		1999	1067 (53.35%)	932 (46.64%)
Yes	N/A	1262 (63.1%)	602 (56.4%)	660 (70.8%)
No	N/A	737 (36.9%)	465 (43.6%)	272 (29.2%)

Note: [a] Hungarian Central Statistical Office: Microcensus 2016; [b] Never married; [c] Employed; [d] other types; [e] XE 1 Euro=388.93 ft; https://www.fizetesek.hu/en/salaries-in-country

4.4.2 Descriptive Statistics of HRQoL and Life Satisfaction Measures

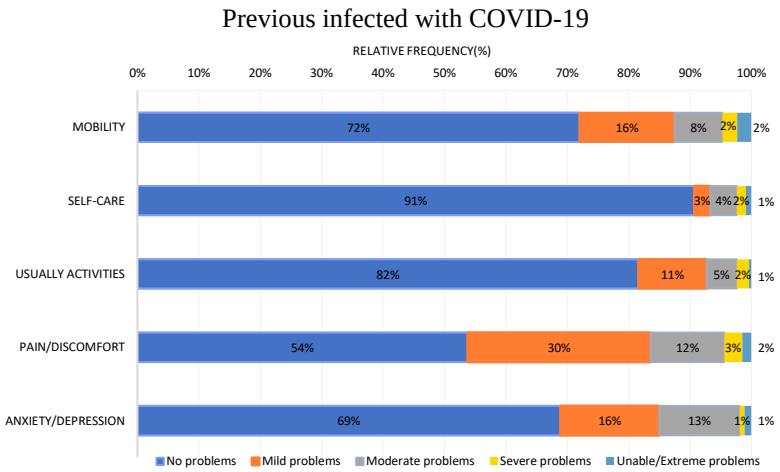
4.4.2.1 EQ-5D-5L Dimension Responses

Figure 2 shows the responses across the five dimensions of EQ-5D-5L, segmented by the participants' COVID-19 infection status, distinguishing between those who have and have not been infected. The assessment of 'any problems' (levels 2-5 on the EQ-5D-5L scale) reveals varying probabilities across dimensions. Pain/discomfort had the highest probability at 47.4%, followed by mobility at 33.2%, anxiety/depression at 32.8%, usual activities at 25.2%, and self-care at 10.7%. Notably, the most significant challenges were in mobility and self-care, with 7.1% and 2.9% of respondents, respectively, reporting severe or extremely severe problems (levels 4 and 5).

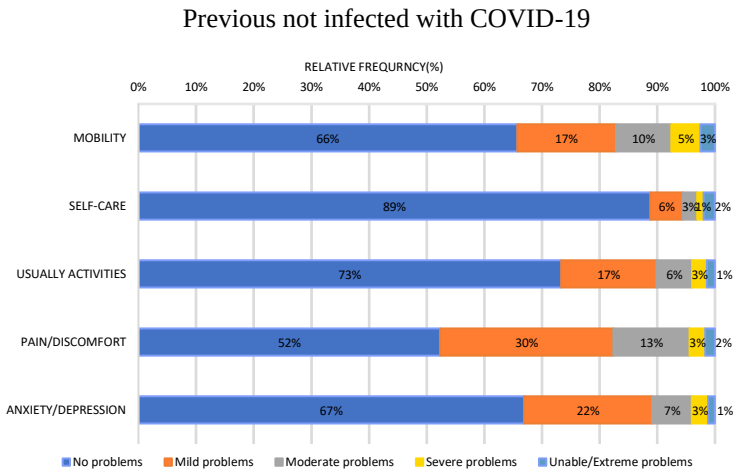
Respondents with personal or familial COVID-19 experience (in the same or a separate household) reported marginally fewer 'any problems' across most dimensions, except for anxiety/depression, compared to their counterparts. In this dimension, the frequency of reported problems among previously infected participants fluctuated between 35.1% and 31.1% across different subgroups. This variation underscores the complex interplay between COVID-19 infection status and HRQoL outcomes, particularly in the psychological domain. Additionally, the same trend of severe and extremely severe problems (levels 4 and 5) was reported for the mobility and self-care dimensions. This analysis illuminates the differential impacts of COVID-19 on HRQoL, highlighting resilience in physical dimensions and vulnerability HRQoL among affected individuals.

Have you been infected with COVID-19?

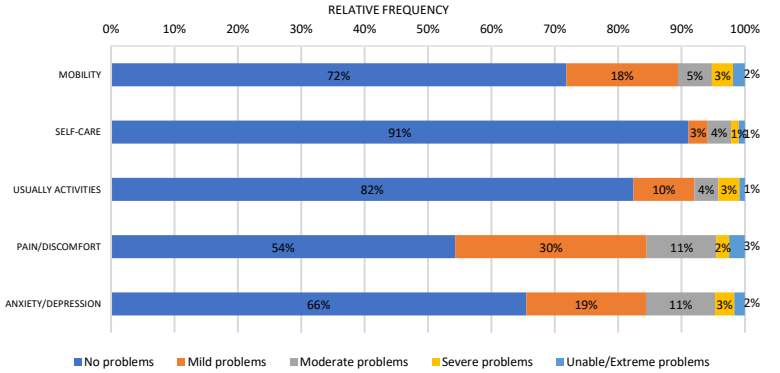
Has anyone in your household been infected with COVID-19?



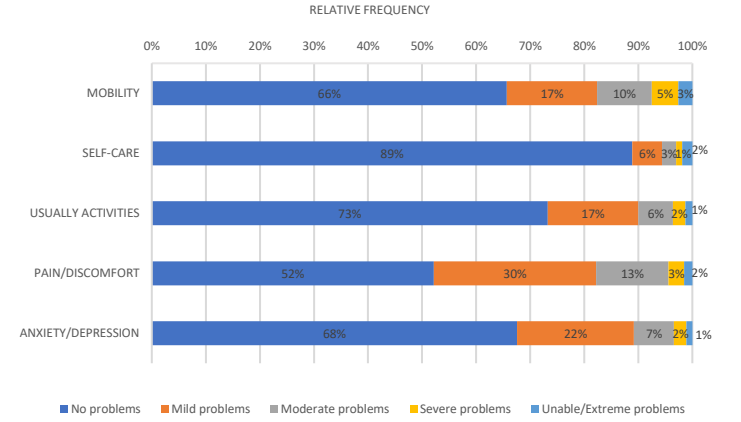
A



B

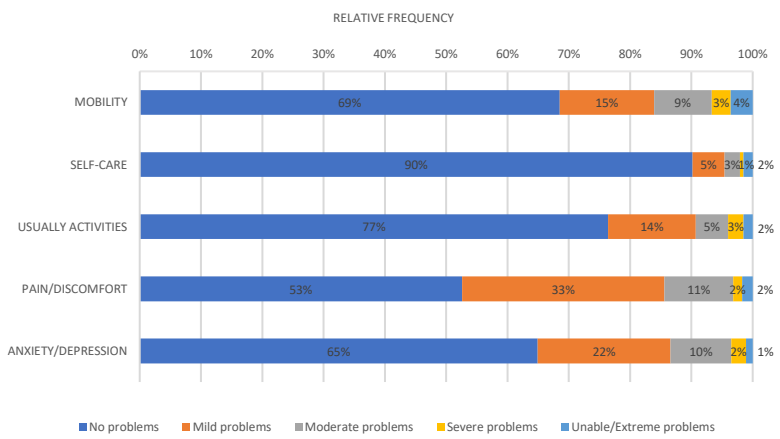


C

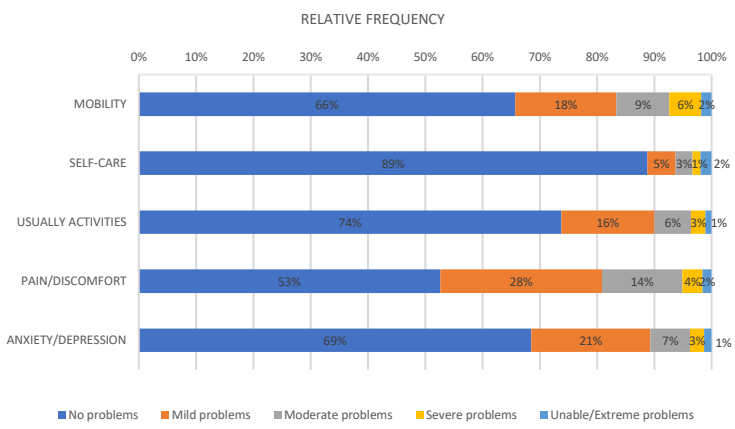


D

Has a close family member not in the household had a COVID-19 infection?



E



F

A, The EQ-5D-5L of respondents who have been infected with COVID-19. B, The EQ-5D-5L of respondents who have not been infected with COVID-19. C, The EQ-5D-5L of respondents who have any family members in the household infected with COVID-19 D, The EQ-5D-5L of respondents who have any family members in the house not infected with COVID-19. E, The EQ-5D-5L of respondents who has a close family member not in the household had a COVID-19 infection. F. The EQ-5D-5L of respondent who has a close family member not in the household had not a COVID-19 infection. Percentages may not total 100 because of rounding.

***Figure** 2 Distribution of responses on the EQ-5D-5L infected and not infected with COVID-19*

4.4.2.2 Relationship Between EQ-5D-5L Utility and Socio-demographic and COVID-19-related Characteristics

The means and standard deviations (SD) of the EQ-5D-5L utility values by participants' demographic and COVID-19-related characteristics are shown in Table 9. The overall mean (±SD) EQ-5D-5L utility value was 0.866 (SD = 0.226), ranging from 0.329 to 0.972. Significant variations in EQ-5D-5L utility were observed across gender ($p < 0.05$), age groups ($p < 0.05$), and educational levels ($p < 0.05$). Specifically, men exhibited a higher utility value (0.883 ± 0.219) compared to women (0.851 ± 0.231). Utility values showed a U-shaped distribution among age groups, with the lowest value in the 55-64 years category (0.796 ± 0.302). Participants with only primary education and those earning less than 899 Euros per month reported lower utility values (0.832 ± 0.258 and 0.827 ± 0.266, respectively).

Among those previously infected with COVID-19, a clear trend was noted which is more severe symptoms were associated with lower HRQoL. Specifically, EQ-5D-5L utility values for participants reporting no symptoms, mild symptoms, severe symptoms, and those requiring hospital or ICU care were 0.929 (SD = 0.138), 0.918 (SD = 0.169), 0.866 (SD = 0.181), and 0.679 (SD = 0.386), respectively. However, no statistically significant variations were found for other COVID-19-related factors, such as quarantine status ($p = 0.06$), and vaccination status ($p = 0.12$). Additional figures could clarify these findings by visually representing the data, improving reader comprehension of the demographic and clinical differences. The implications of these variations in utility values, especially the significant impact of severe COVID-19 symptoms on HRQoL, require further discussion regarding their potential influence on public health strategies and clinical interventions.

Table 9 Mean EQ-5D-5L utility by socio-demographic characteristics and COVID-19 infection

			COVID-19 related variables										
			Have you been infected with COVID-19?			Has anyone in your household been infected with COVID-19?				Has a close family member not in the household had a COVID-19 infection?			
	N	All Mean (SD)	N	Mean (SD) Yes	N	Mean (SD) No	N	Mean (SD) Yes	N	Mean (SD) No	N	Mean (SD) Yes	N	Mean (SD) No
		0.866		0.885		0.862		0.876		0.864				0.863
All respondents	2000	(0.226)	351	(0.187)	1649	(0.234)	341	(0.226)	1659	(0.226)	734	0.870 (0.218)	1266	(0.231)
Age (years)		0.919		0.885		0.929		0.868		0.942				0.924
18-24	212	(0.166)	49	(0.188)	163	(0.159)	65	(0.264)	147	(0.089)	113	0.915 (0.185)	99	(0.142)
		0.894		0.879		0.897		0.912		0.890				0.894
25-34	338	(0.166)	63	(0.204)	275	(0.156)	59	(0.123)	279	(0.173)	145	0.894 (0.154)	194	(0.174)
		0.915		0.915		0.915		0.918		0.914				0.913
35-44	376	(0.147)	78	(0.136)	298	(0.150)	78	(0.142)	298	(0.149)	132	0.918 (0.136)	243	(0.153)
		0.831		0.906		0.813		0.875		0.821				0.838
45-54	309	(0.272)	59	(0.158)	250	(0.290)	54	(0.216)	256	(0.282)	81	0.808 (0.271)	229	(0.273)
		0.796		0.830		0.789		0.779		0.799				0.804
55-64	352	(0.302)	65	(0.247)	287	(0.313)	54	(0.342)	299	(0.294)	123	0.781 (0.331)	229	(0.284)
		0.855		0.895		0.852		0.887		0.853				0.845
65+	412	(0.222)	36	(0.153)	376	(0.228)	32	(0.199)	380	(0.224)	139	0.878 (0.166)	273	(0.245)
Gender		0.883		0.891		0.881		0.858		0.888				0.882
Male	933	(0.219)	174	(0.195)	759	(0.225)	172	(0.254)	760	(0.211)	329	0.884 (0.222)	603	(0.218)
		0.851		0.879		0.845		0.894		0.843				0.846
Female	1067	(0.231)	177	(0.178)	890	(0.239)	169	(0.193)	898	(0.237)	404	0.859 (0.214)	663	(0.241)
Education		0.832		0.876		0.823		0.868		0.825				0.833
Primary school	1020	(0.258)	171	(0.198)	848	(0.268)	159	(0.237)	861	(0.262)	322	0.830 (0.252)	698	(0.261)

			COVID-19 related variables									
			Have you been infected with COVID-19?			Has anyone in your household been infected with COVID-19?			Has a close family member not in the household had a COVID-19 infection?			
	N	All Mean (SD)	N	Mean (SD) Yes	N	Mean (SD) No	N	Mean (SD) Yes	N	Mean (SD) No	N	Mean (SD) Yes	N	Mean (SD) No
		0.888		0.881		0.890		0.859		0.895				0.888
Intermediate level	627	(0.196)	121	(0.179)	506	(0.200)	121	(0.241)	506	(0.184)	260	0.889 (0.193)	367	(0.199)
		0.922		0.918		0.923		0.927		0.921				0.922
Higher education	354	(0.144)	59	(0.162)	295	(0.140)	62	(0.148)	292	(0.143)	152	0.921 (0.156)	202	(0.134)
Employment		0.916		0.907		0.918		0.905		0.918				0.920
Employed full-time	845	(0.144)	177	(0.171)	668	(0.136)	168	(0.170)	677	(0.137)	321	0.908 (0.161)	534	(0.133)
		0.861		0.909		0.850		0.922		0.845				0.828
Employed part time	131	(0.249)	24	(0.112)	106	(0.271)	27	(0.077)	104	(0.275)	50	0.914 (0.100)	80	(0.304)
		0.947		0.905		0.961		0.967		0.942				0.956
Entrepreneur	49	(0.084)	13	(0.120)	37	(0.064)	10	(0.033)	40	(0.093)	20	0.934 (0.105)	29	(0.067)
		0.829		0.905		0.819		0.802		0.835				0.905
Unemployed	111	(0.299)	13	(0.121)	98	(0.314)	19	(0.387)	93	(0.280)	39	0.686 (0.449)	73	(0.121)
		0.905		0.794		0.961		0.852		0.925				0.902
Student	98	(0.189)	33	(0.285)	65	(0.061)	28	(0.223)	71	(0.171)	45	0.909 (0.112)	54	(0.235)
		0.876		0.906		0.870		0.926		0.866				0.893
Takes care of family members	122	(0.181)	19	(0.100)	103	(0.192)	20	(0.091)	102	(0.193)	52	0.852 (0.230)	70	(0.133)
		0.841		0.885		0.835		0.894		0.836				0.823
Retired	505	(0.229)	57	(0.157)	449	(0.236)	46	(0.183)	459	(0.232)	165	0.878 (0.161)	340	(0.254)
		0.490		0.467		0.492		0.349		0.519				0.503
Disabled pensioner	80	(0.379)	7	(0.321)	74	(0.385)	14	(0.433)	67	(0.363)	25	0.462 (0.398)	55	(0.373)
Inactively seeking		0.827		0.971		0.799		0.902		0.794				0.860
employment	29	(0.184)	5	(0.062)	24	(0.187)	9	(0.113)	20	(0.201)	11	0.776 (0.186)	18	(0.180)

			COVID-19 related variables									
			Have you been infected with COVID-19?			Has anyone in your household been infected with COVID-19?			Has a close family member not in the household had a COVID-19 infection?			
	N	All Mean (SD)	N	Mean (SD) Yes	N	Mean (SD) No	N	Mean (SD) Yes	N	Mean (SD) No	N	Mean (SD) Yes	N	Mean (SD) No
		0.738		0.890		0.717		0.917		0.728				0.691
Other occupational status	28	(0.437)	3	(0.059)	25	(0.462)	2	(0.002)	27	(0.448)	5	0.972 (0.043)	24	(0.466)
Monthly income (Euro)		0.827		0.859		0.822		0.821		0.828				0.829
0- 899	1105	(0.266)	155	(0.208)	950	(0.274)	146	(0.289)	959	(0.263)	359	0.824 (0.262)	745	(0.268)
		0.918		0.900		0.923		0.908		0.921				0.917
900 – 2571	507	(0.129)	105	(0.167)	402	(0.116)	104	(0.159)	403	(0.120)	218	0.920 (0.113)	288	(0.139)
		0.930		0.962		0.922		0.963		0.920				0.887
2572+	26	(0.127)	5	(0.070)	21	(0.138)	6	(0.067)	20	(0.140)	11	0.990 (0.026)	15	(0.153)
		0.905		0.909		0.903		0.924		0.898				0.908
I don’t know / I don’t answer	363	(0.179)	86	(0.167)	277	(0.183)	86	(0.149)	277	(0.187)	146	0.899 (0.200)	218	(0.164)
Have you been quarantined?		0.883		0.920		0.822		0.901		0.853				0.905
Yes	330	(0.227)	204	(0.134)	126	(0.316)	205	(0.193)	125	(0.271)	192	0.866 (0.268)	139	(0.151)
		0.862		0.836		0.864		0.838		0.864				0.858
No	1670	(0.226)	147	(0.232)	1523	(0.225)	136	(0.264)	1533	(0.222)	542	0.871 (0.197)	1128	(0.238)
Have you been vaccinated against COVID-19?		0.871		0.893		0.867		0.874		0.870				0.875
Yes	1262	(0.213)	173	(0.180)	1089	(0.218)	183	(0.240)	1079	(0.208)	438	0.863 (0.225)	824	(0.206)
		0.856		0.877		0.849		0.878		0.850				0.840
No	738	(0.246)	178	(0.192)	560	(0.261)	159	(0.209)	579	(0.256)	295	0.880 (0.207)	443	(0.269)

4.4.2.3 Descriptive Statistics and the Distribution of Perceived Anxiety, Depression, and Level of Life Satisfaction

In this research, Figure 3 shows how the different anxiety, depression, and life satisfaction categories were distributed in the sample. A significant proportion of participants exhibited symptoms, with 48.1% experiencing depression, 41.5% reporting anxiety, and 41.9% expressing dissatisfaction with their life during the pandemic. The mean scores for anxiety (GAD) were at 4.84 (SD = 5.25), indicating minimal anxiety. The mean scores for depression (PHQ) were 6.07 (SD = 6.07), suggesting mild symptoms. Life satisfaction (SWLS) averaged 20.25 (SD = 7.67), with scores categorized as less (5–20) and more (21–35) life satisfaction (Pavot and Diener, 1993).

Regarding the severity of mental health symptoms, 7.1%, 9.2%, and 25.3% of participants experienced severe, moderate, and mild anxiety symptoms, respectively. Additionally, 11.4% and 10.2% of participants had severe and moderate symptoms of depression, indicating a higher prevalence of depression compared to anxiety. Notably, 11.6% of participants reported being extremely dissatisfied with their life, underscoring the pandemic's substantial impact on mental well-being. These findings suggest a need for targeted mental health interventions to address the high levels of depression and life dissatisfaction observed among participants.

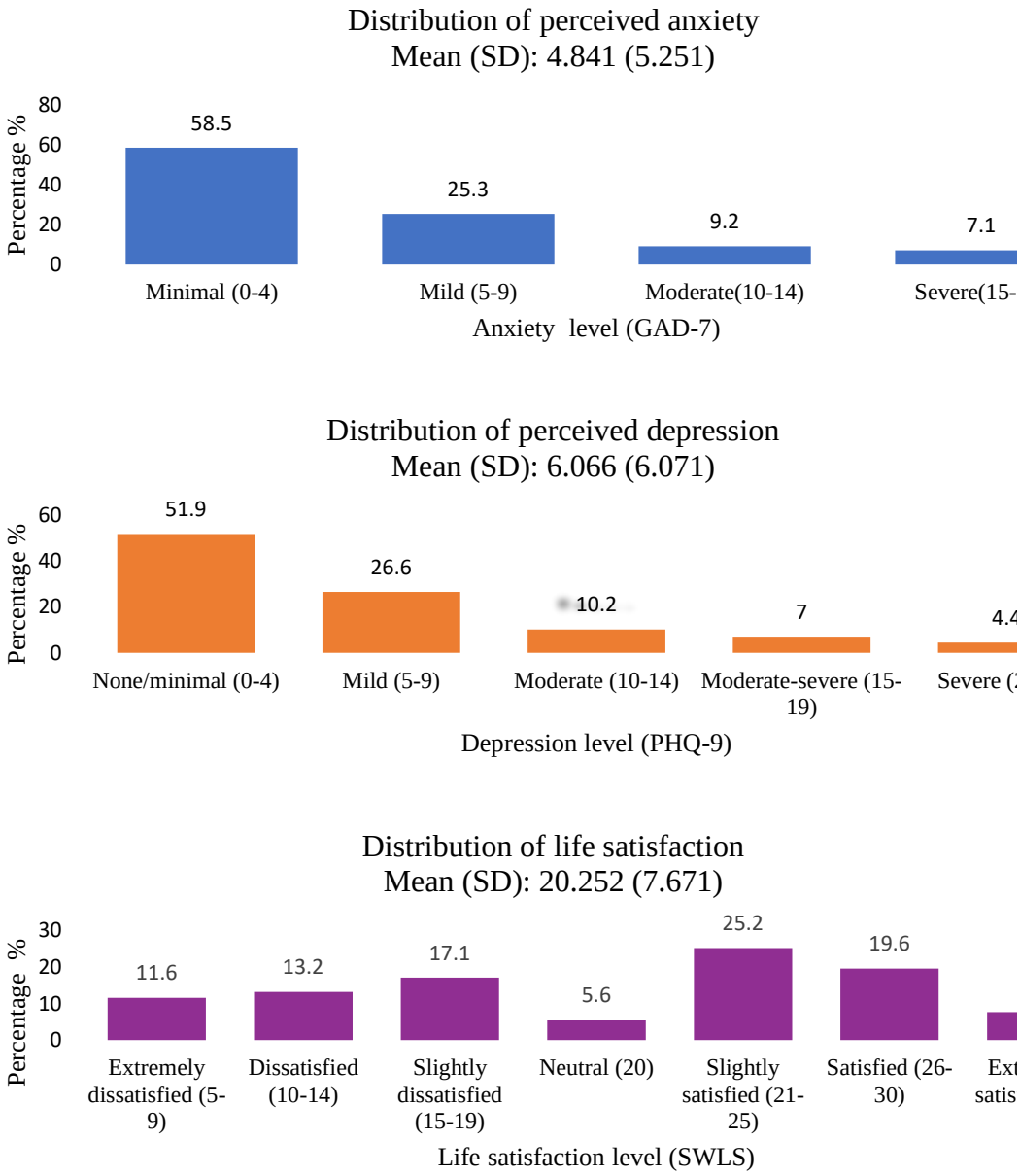


***Figure** 3 Distribution of perceived anxiety, depression, and level of life satisfaction*

4.4.3 Factors Associated with HRQoL and Life Satisfaction

4.4.3.1 Factors Associated with HRQoL

The logistic regression odds ratios for reporting any problems (levels 2-5) in each of the EQ-5D-5L dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) are presented in Table 10 (Appendix Table 8). This analysis reveals that the probability of reporting problems increased significantly with age across all dimensions except anxiety/depression, indicating the pronounced impact of

aging on physical health aspects. In contrast, male participants demonstrate lower odds of encountering issues in the pain/discomfort and anxiety/depression dimensions, suggesting potential gender-based differences in health perception or resilience. Socioeconomic factors emerge as protective, with higher education, full-time employment, and higher monthly income levels all associated with reduced reports of problems across all dimensions. These associations underline the critical influence of socioeconomic status on health outcomes, emphasizing the need for interventions that bolster socioeconomic support to enhance HRQoL.

Respondents with a previous COVID-19 infection reported significantly fewer problems in the mobility and usual activities dimensions. However, severe symptoms of COVID-19 infection were associated with an increased frequency of problems in the mobility and pain/discomfort dimensions, underscoring the long-term health impacts of severe infections. Respondents who had been quarantined were less likely to report problems in the mobility, self-care, and usual activities dimensions, potentially reflecting the health state of individuals who undergo quarantine or their health behaviors post-quarantine. Vaccination status also plays a role, with vaccinated respondents reporting more problems in the mobility dimension and fewer problems in the pain/discomfort dimension, suggesting areas for further research into the indirect effects of vaccination on health perceptions and quality of life.

Table 10 Odds ratios for comparing HRQoL outcomes across EQ-5D-5L dimensions

Category definition	MOBILITY			SELF-CARE			USUAL ACTIVITIES			PAIN/DISCOMFORT			ANXIETY/DEPRESSION		
	No problems (Level 1) vs. Any problems (Levels 2-5)			No problems (Level 1) vs. Any problems (Levels 2-5)			No problems (Level 1) vs. Any problems (Levels 2-5)			No problems (Level 1) vs. Any problems (Levels 2-5)			No problems (Level 1) vs. Any problems (Levels 2-5)		
Variable	**OR**	**Lo**	**Hi**	**OR**	**Lo**	**Hi**	**OR**	**Lo**	**Hi**	**OR**	**Lo**	**Hi**	**OR**	**Lo**	**Hi**
Age (years)															
18-24	1			1			1			1			1		
25-34	1.812	0.984	3.336	2.972	0.986	8.958	1.517	0.819	2.808	**1.933**	1.236	3.025	1.034	0.671	1.595
35-44	1.717	0.929	3.173	2.257	0.729	6.983	1.218	0.65	2.282	**1.624**	1.035	2.549	0.791	0.509	1.228
45-54	**3.303**	1.774	6.151	**4.052**	1.313	12.505	**2.027**	1.071	3.836	**1.973**	1.224	3.18	**0.662**	0.412	1.064
55-64	**5.014**	2.69	9.344	**3.201**	1.031	9.938	**2.759**	1.459	5.218	**2.79**	1.72	4.526	**0.525**	0.323	0.856
65 +	**4.9**	2.469	9.725	1.429	0.436	4.685	**2.041**	1.007	4.139	**2.206**	1.254	3.88	**0.392**	0.218	0.705
Gender															
Female	1			1			1			1			1		
Male	1.235	0.989	1.541	0.904	0.655	1.247	1.09	0.861	1.38	**1.394**	1.143	1.7	**1.424**	1.152	1.76
Education															
Primary school	1			1			1			1			1		
Intermediate level	0.83	0.639	1.078	1.042	0.712	1.526	0.89	0.676	1.172	**0.792**	0.628	0.998	0.964	0.752	1.235
Higher education	**0.699**	0.506	0.966	0.771	0.458	1.3	**0.645**	0.45	0.923	**0.575**	0.432	0.765	0.944	0.695	1.283
Employment															
Employed full-time	1			1			1			1			1		
Employed part time	1.233	0.795	1.913	1.421	0.688	2.937	1.392	0.872	2.221	1.15	0.779	1.698	1.465	0.983	2.182
Entrepreneur	1.043	0.509	2.136	1.497	0.456	4.92	0.734	0.292	1.847	1.141	0.618	2.105	0.824	0.407	1.669
Unemployed	**1.643**	1.043	2.589	**2.013**	1.017	3.982	1.544	0.949	2.513	1.134	0.747	1.722	1.51	0.987	2.311
Student	0.523	0.196	1.399	1.539	0.386	6.126	**2.267**	1.087	4.727	1.741	0.99	3.064	1.26	0.725	2.189
Takes care of family members	0.964	0.59	1.576	0.866	0.345	2.177	1.304	0.789	2.154	0.774	0.513	1.168	1.162	0.768	1.76
Retired	**2.042**	1.371	3.041	**5.468**	3.092	9.668	**2.054**	1.34	3.147	**1.495**	1.012	2.207	1.298	0.845	1.994
Disabled pensioner	**14.05**	6.935	28.445	**13.78**	7.571	25.068	**18.569**	9.491	36.33	**7.541**	3.677	15.47	**8.286**	4.695	14.622
Inactively seeking employment	**3.064**	1.376	6.821	**4.544**	1.676	12.317	**2.469**	1.043	5.846	1.421	0.657	3.072	**2.914**	1.349	6.295
Other occupational status	1.891	0.833	4.29	**3.035**	1.033	8.921	0.664	0.232	1.902	1.434	0.651	3.159	1.617	0.74	3.532

Monthly income (Euro)															
0-899	1			1			1			1			1		
900 – 2571	0.884	0.675	1.157	**0.575**	0.361	0.917	**0.71**	0.529	0.952	0.917	0.723	1.163	0.79	0.611	1.021
2572 +	1.089	0.393	3.019	0	0		0.383	0.087	1.688	0.498	0.196	1.263	**0.212**	0.057	0.787
I don't know / I don't answer	**0.549**	0.401	0.75	0.879	0.572	1.351	**0.563**	0.404	0.785	0.69	0.532	0.894	**0.653**	0.494	0.863
Have you been infected with COVID-19?															
Yes	1			1			1			1			1		
No	3.396	0.936	12.328	1.341	0.235	7.661	3.089	0.69	13.82	2.09	0.882	4.953	1.883	0.733	4.841
Has anyone in your household been infected with COVID-19															
Yes	1			1			1			1			1		
No	0.901	0.608	1.335	1.067	0.588	1.935	1.43	0.921	2.22	0.973	0.695	1.361	0.879	0.617	1.252
Has a close family member not in the household had a COVID-19 infection?															
Yes	1			1			1			1			1		
No	0.929	0.74	1.167	0.917	0.653	1.287	0.924	0.726	1.177	0.89	0.727	1.09	0.836	0.675	1.035
Severity of COVID-19 infection															
No symptoms were observed	1			1			1			1			1		
Mild symptoms that did not affect daily activities	2.776	0.727	10.601	1.058	0.164	6.809	1.574	0.321	7.714	1.401	0.562	3.492	1.299	0.474	3.558
Perceived severe symptoms that limited daily activities (e.g., needed bed rest)	**3.966**	1.073	14.662	2.065	0.349	12.23	4.013	0.876	18.37	2.703	1.116	6.545	2.178	0.829	5.724
Needed hospital care or intensive care unit care	**13.49**	1.839	98.912	4.679	0.49	44.732	6.773	0.933	49.15	3.341	0.618	18.06	3.321	0.65	16.972
Have you been quarantined?															
Yes	1			1			1			1			1		
No	1.061	0.736	1.529	1.483	0.821	2.681	0.994	0.667	1.482	0.932	0.683	1.274	1.18	0.847	1.642
Have you been vaccinated against COVID-19?															
Yes	1			1			1			1			1		
No	1.078	0.852	1.364	1.23	0.874	1.731	0.962	0.75	1.234	1.416	1.153	1.74	0.936	0.754	1.161

Or in bold are statistically significant; Or: odds ratio; Lo: lower limit; Hi: upper limit.

The linear regression analysis explored the relationship between EQ-5D-5L utility and various demographic, socioeconomic, and COVID-19-related factors (Table 11). For the model, the R^2 value was 0.094, indicating that independent variables explained 9.4% of the variance in the dependent variable. The F-statistic ($F = 18.735$, $p < 0.001$) indicated statistical significance. Throughout these analyses, diagnostic parameters were carefully examined to ensure model robustness. Collinearity statistics revealed VIF values well below the threshold of concern, indicating no significant multicollinearity among predictors. The condition index and variance proportions confirmed that multicollinearity was not an issue. Collinearity diagnostics further validated the model's stability. For example, the condition indices and variance proportions across different models indicated no significant issues, with most dimensions showing acceptable variance proportions. These diagnostic evaluations affirm the reliability and validity of the linear regression models (Appendix Table 6 and Appendix Table 7).

For socio-demographic characteristics, employment status emerged as a critical determinant of HRQoL. Specifically, with β values of -0.016 ($p<0.001$), indicating these conditions substantially reduce HRQoL. Conversely, higher educational attainment and increased monthly income positively impact HRQoL. Specifically, β value with higher education ($\beta = 0.039$, $p < 0.001$) and income levels ($\beta = 0.016$, $p < 0.001$) were reported significantly better HRQoL, highlighting the importance of education and monthly income in enhancing HRQoL.

The analysis revealed the profound impact of severe COVID-19 infection, factors such as having had a COVID-19 infection ($\beta = -0.073$, $p<0.05$) showed a direct significant association with the EQ-5D-5L utility. Particularly requiring hospital or ICU care, on diminishing HRQoL ($\beta = -0.037$, $p < 0.05$). This finding highlights the lasting negative effects of severe illness on individuals' perceptions of their HRQoL. Interestingly, factors such as quarantine and vaccinate status did not show a direct significant association with the EQ-5D-5L utility. This suggests that the immediate effects of COVID-19, quarantine and vaccinate experiences may not straightforwardly influence overall HRQoL, or their impacts may be offset by other factors.

Table 11 Linear regression analysis of HRQoL using EQ-5D-5L utility

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Age (years)	-0.001	0.000	-0.048	-1.913	0.056	-0.001	0.000	0.722	1.385
Gender	-0.012	0.010	-0.027	-1.203	0.229	-0.032	0.008	0.905	1.105
Education	**0.039**	0.007	0.130	5.929	0.000	0.026	0.052	0.945	1.058
Employment	**-0.016**	0.002	-0.200	-8.160	0.000	-0.020	-0.012	0.759	1.317
Monthly income (Euro)	**0.016**	0.004	0.081	3.675	0.000	0.008	0.025	0.928	1.078
Have you been infected with COVID-19?	**-0.073**	0.030	-0.123	-2.420	0.016	-0.132	-0.014	0.177	5.640
Has anyone in your household been infected with COVID-19?	0.019	0.017	0.032	1.114	0.265	-0.015	0.053	0.549	1.821
	0.007	0.011	0.014	0.625	0.532	-0.014	0.027	0.909	1.100
Severity of COVID-19 infection	**-0.037**	0.017	-0.103	-2.176	0.030	-0.070	-0.004	0.204	4.911
Have you been quarantined?	-0.003	0.016	-0.005	-0.171	0.865	-0.035	0.029	0.645	1.549
Have you been vaccinated against COVID-19?	-0.020	0.011	-0.042	-1.836	0.067	-0.040	0.001	0.888	1.126

a. Dependent Variable: EQ_5D_5L_INDEX

4.4.3.2 Factors Associated with Life Satisfaction and Mental Health

Significance of differences according to socioeconomics and COVID-19 characteristics

One-way ANOVA was used to assess the significance of differences in life satisfaction, anxiety and depression based on the categorical ranges in Table 12, considering normality and assuming equal variance across groups. Significant differences in gender, age, marital status, education level, net monthly income, employment status, direct COVID-19 experience, severity of infection, COVID-19 experience of family members, quarantine status, and vaccination status were investigated using a one-way ANOVA test ($p< 0.05$ considered significant). Pairwise comparisons were conducted using post-hoc Tukey's multiple comparison test.

There were no significant differences in life satisfaction according to gender and severity of infection ($p > 0.05$). However, age significantly affected life satisfaction ($F = 7.1$; $p < 0.001$), with a notable U-shaped pattern suggesting varying levels of satisfaction across life stages. Individual aged 45-54 and 55-64 (M = 18.82 and 18.93) reported higher dissatisfaction, those aged 25-34 and 35-44 (M = 20.42 and 20.78) showed neutral life satisfaction, and both the youngest (18-24) and oldest (65+) groups (M = 21.44 and 21.23) experienced higher satisfaction. Marital status significantly affected life satisfaction, with single participants reporting the lowest levels. Significant differences were found among other marital status ($F = 31.995$, $p < 0.001$), underscoring the positive impact of companionship on SWB. Educational attainment also played a crucial role, with university educated participants ($F = 22.29$, $p < 0.001$) reporting the highest life satisfaction levels compared to their counterparts, highlighting the protective effects of higher education on life satisfaction. Employment status further differentiated satisfaction levels, with unemployed participants (M = 16.81) showing the lowest life satisfaction. Significant differences were found among other employment status (expecting to work part-time and inactive looking for a job; $F = 9.01$, $p < 0.001$), suggesting financial stability and occupational engagement are key contributors to HRQoL. Additionally, higher monthly income was positively correlated with increased life satisfaction ($F = 32.748$, $p < 0.001$), emphasizing the importance of economic factors. Interestingly, those infected with COVID-19 reported higher satisfaction compared to the uninfected (M = 21.91 and 21.45, and 21.05 vs. M = 19.90, and 20.01 vs. 19.79), suggesting potential resilience

or adaptation mechanisms. Quarantine and vaccination were also significant factors associated with higher life satisfaction.

In terms of anxiety, direct COVID-19 experience, and quarantine status did not significantly affect anxiety levels ($p > 0.05$), indicating these factors alone do not predispose individuals to higher anxiety. However, specific demographic groups, including men, those aged 65 and over, widows, university-educated individuals, entrepreneurs, and pensioners, reported lower anxiety levels. In contrast, participants who required hospital or ICU care due to the COVID-19 infection, family members diagnosed with COVID-19, and respondents who had not been vaccinated against COVID-19 were associated with higher anxiety levels.

Regarding depression, the overall mild symptoms observed suggest a moderate impact of the pandemic on depression levels among Hungarian adults. Those aged 65 and over, widows, university-educated individuals, entrepreneurs, those with a monthly income of more than 2572 Euros, and those with mild symptoms of infection severity reported no symptoms of depression. Women ($M = 6.92$) had higher depression scores than men ($M = 5.09$). Participants aged 25-34 years ($M = 7.96$), singles ($M = 7.55$), those with primary education ($M = 6.49$), students ($M = 7.8$), and those with lower monthly income ($M=6.75$) reported the highest depression scores, identifying them as the most vulnerable groups. Additionally, requiring hospital and ICU care ($M = 8.17$) and not being vaccinated against COVID-19 ($M = 6.75$) were associated with the highest depression scores within their groups, making them the most significant source of depression symptoms. In contrast, participants' own direct COVID-19 experience, their family members' COVID-19 experience (whether living in the same house or living separately), and quarantine status showed no significant differences on the depression scale, indicating that other factors play a more pivotal role in mental health outcomes.

Table 12 Significant differences in life satisfaction, anxiety and depression outcomes according to socioeconomic and COVID-19 characteristics

Demographics		SWLS			Anxiety			Depression		
		MEAN	F	P	MEAN	F	P	MEAN	F	P
Gender	Female	20.206			5.665			6.920		
	Male	20.305			3.898			5.089		
	TOTAL	20.252	0.083	0.774	4.841	57.935	<0.001	6.066	46.279	<0.001
Age categories (years)	18-24	21.436			6.060			7.211		
	25-34	20.418			6.597			7.956		
	35-44	20.782			4.998			5.802		
	45-54	18.816			4.765			5.834		
	55-64	18.933			4.537			6.094		
	65 +	21.230			2.944			4.316		
	TOTAL	20.252	7.1	<0.001	4.841	22.024	<0.001	6.066	15.703	<0.001
Marital status	Unique	17.484			5.639			7.554		
	Married	22.205			4.204			5.058		
	Divorced	18.592			4.910			6.568		
	Widow	19.849			3.472			4.912		
	Lives in a cohabitation relationship	20.339			5.562			6.508		
	TOTAL	20.252	31.995	<0.001	4.841	10.062	<0.001	6.066	14.903	<0.001
Education	Primary education	19.266			5.147			6.488		
	Second education	20.718			4.941			6.124		
	University education	22.271			3.781			4.745		
	TOTAL	20.252	22.29	<0.001	4.841	9.12	<0.001	6.066	10.977	<0.001
Employment	Full-time employment	20.766			4.739			5.805		
	Part-time employment	18.903			5.565			6.504		
	Entrepreneur	22.790			3.123			3.989		
	Unemployed	16.180			6.279			7.640		
	Student	21.188			6.583			7.820		
	Household activities	22.099			6.387			6.593		
	Pensioner	20.111			3.938			5.621		

Demographics		SWLS			Anxiety			Depression		
	Inactive looking for job	17.392			6.329			8.055		
	TOTAL	20.252	9.01	<0.001	4.841	8.771	<0.001	6.066	4.916	<0.001
Monthly net income (Euros)	Low (0-899)	18.977			5.3843			6.7531		
	Middle (900-2571)	22.669			4.24			5.1745		
	High (2572+)	25.675			2.3094			2.4009		
	I don't know /I don't answer	20.377			4.2051			5.4787		
	Total	20.252	32.748	<0.001	4.8408	10.055	<0.001	6.0659	12.839	<0.001
Have you been infected with COVID-19?	Yes	21.908			5.109			5.955		
	No	19.900			4.784			6.090		
	TOTAL	20.252	20.026	<0.001	4.841	1.113	0.292	6.066	0.143	0.705
Have your family member in house been infected with COVID-19?	Yes	21.446			5.658			6.633		
	No	20.007			4.673			5.949		
	TOTAL	20.252	10.019	<0.001	4.841	10.006	<0.001	6.066	3.592	0.058
Have your family member NOT in house been infected with COVID-19?	Yes	21.045			5.284			6.182		
	No	19.793			4.584			5.998		
	TOTAL	20.252	12.43	<0.001	4.841	8.294	<0.001	6.066	0.426	0.514
Where have you been contract with COVID during your illness?	No symptoms	20.321			3.386			5.170		
	Mild symptoms	21.395			3.954			4.638		
	Severe symptoms	22.447			6.119			6.879		
	Needed hospital care or placed in the intensive care unit	23.383			6.487			8.170		
	TOTAL	21.908	1.164	0.324	5.109	5.378	0.001	5.955	4.598	0.004
Have you been in quarantine?	Yes	21.796			5.039			5.974		
	No	19.947			4.802			6.084		
	TOTAL	20.252	16.141	<0.001	4.841	0.564	0.453	6.066	0.09	0.764
Have you been vaccinated against COVID?	Yes	20.894			4.346			5.665		
	No	19.156			5.687			6.752		
	TOTAL	20.252	24.179	<0.001	4.841	30.791	<0.001	6.066	15.027	<0.001

The multiple linear regression analysis across depression, anxiety, and life satisfaction (measured by PHQ-9, GAD-7, and SWLS respectively) reveals a shared, moderate correlation between the predicted and observed scores for these outcomes, underscoring the utility of the sociodemographic and COVID-19-related predictors while acknowledging the complexity of these constructs (Table 13).

The models for depression, anxiety, and life satisfaction show comparable R values: 0.288 for depression, 0.325 for anxiety, and 0.239 for SWLS. These R values reflect moderate correlations, indicating that the predictors collectively capture a meaningful relationship with each outcome, even if only a portion of the variability is explained. The results suggest that the models successfully identify patterns in these psychological measures, while still allowing room for additional variables that could enhance predictive power and reflect the multifactorial nature of depression, anxiety, and life satisfaction. The R^2 values of the three models — 0.083 for depression, 0.105 for anxiety, and 0.057 for SWLS — illustrate that the models explain 8.3%, 10.5%, and 5.7% of the variance in each outcome, respectively. While these values appear modest, they highlight that the included predictors do have substantive relevance. The Adjusted R^2 values further moderate the explanatory power slightly (0.07 for depression, 0.1 for anxiety, and 0.051 for SWLS), reinforcing the validity of the models without overstating their impact, especially in light of the intricate, multifaceted nature of these psychological outcomes.

Each model demonstrates statistical significance through its respective F-statistics from ANOVA: 14.9 for depression, 19.5 for anxiety, and 10.032 for SWLS, all with p-values below 0.0001. These results confirm that the predictors improve the model's fit significantly over a null model for each outcome, lending credibility to their utility in explaining variations in depression, anxiety, and life satisfaction. Taken together, the regression analyses for depression, anxiety, and life satisfaction indicate that sociodemographic and COVID-19-related factors meaningfully contribute to understanding these outcomes. Although the models capture a moderate amount of variance, their statistically significant results suggest they are valuable for initial exploration, even as further research may integrate additional predictors to account for the remaining unexplained variability (Appendix Table 7).

Notably, in terms of socio-demographic and COVID-19-realted characteristics, age, education, monthly net income, diagnosis of participants' family member in house were negatively associated with both depression and anxiety levels. Specifically, the

analysis indicated that older participants, those who have higher education level, higher monthly income, and participants' family member in house have not been infected with COVID-19 were likely to report lower levels of depression and anxiety, with all regression coefficients being negative and statistically significant ($\beta < 0$, $p < 0.05$). Conversely, gender, employment, participants' direct COVID-19 infection, and the severity of COVID-19 infections emerged as a significant predictor of increased depression and anxiety scores. Similarly, undergoing quarantine was linked to a marked increase in anxiety scores by 0.780 points (all $\beta > 0$, $p < 0.05$).

For life satisfaction, married status, higher education level and monthly income were significantly associated with increased life satisfaction ($\beta > 0$, $p < 0.05$). Surprisingly, an increased severity of COVID-19 infection was associated with slightly higher life satisfaction, evidenced by a 1.268-point increase in SWLS scores ($p = 0.03$). This counterintuitive finding suggests the need for further investigation to explore potential underlying mechanisms or confounding variables that might explain this relationship. Additionally, unvaccinated participants were more likely to report decreased life satisfaction ($\beta < 0$, $p < 0.001$).

Table 13 Assessing the impact of sociodemographic and COVID-19 characteristics on depression, anxiety and life satisfaction: a multiple linear regression analysi

	DEPRESSION (PHQ-9 score)						ANXIETY (GAD-7 score)						SWLS			
		95.0% Confidence Interval for B		Collinearity Statistics			95.0% Confidence Interval for B		Collinearity Statistics				95.0% Confidence Interval for B		Collinearity Statistics	
B	**Sig.**	**Lower Bound**	**Upper Bound**	**Tolerance**	**VIF**	**B**	**Sig.**	**Lower Bound**	**Upper Bound**	**Tolerance**	**VIF**	**B**	**Sig.**	**Lower Bound**	**Upper Bound**	**Tolerance**	**VIF**
Age																	
-0.771	0.000	-0.951	-0.590	0.728	1.373	**-0.745**	0.000	-0.899	-0.591	0.728	1.373	0.000	0.997	-0.231	0.232	0.728	1.373
Gender																	
1.277	0.000	0.729	1.826	0.875	1.143	**1.188**	0.000	0.720	1.656	0.875	1.143	0.184	0.608	-0.518	0.886	0.875	1.143
Marital status																	
-0.175	0.056	-0.355	0.004	0.953	1.050	-0.051	0.515	-0.205	0.103	0.953	1.050	**0.292**	0.013	0.062	0.523	0.953	1.050
Education																	
-0.808	0.000	-1.155	-0.460	0.939	1.065	**-0.632**	0.000	-0.929	-0.335	0.939	1.065	**1.211**	0.000	0.765	1.656	0.939	1.065
Employment																	
0.190	0.000	0.087	0.292	0.767	1.304	**0.114**	0.011	0.026	0.201	0.767	1.304	-0.106	0.112	-0.237	0.025	0.767	1.304
Monthly net income																	
-0.479	0.000	-0.716	-0.243	0.929	1.076	**-0.473**	0.000	-0.675	-0.272	0.929	1.076	**0.412**	0.008	0.109	0.714	0.929	1.076
Have you been infected with COVID-19?																	
2.369	0.004	0.773	3.966	0.177	5.640	**2.375**	0.001	1.011	3.739	0.177	5.640	0.219	0.833	-1.826	2.265	0.177	5.640
Has your family member in house been infected with COVID-19?																	
-1.314	0.005	-2.232	-0.396	0.548	1.825	**-1.151**	0.004	-1.935	-0.367	0.548	1.825	0.420	0.484	-0.756	1.596	0.548	1.825
Has your family member not in house been infected with COVID-19?																	
-0.082	0.774	-0.639	0.476	0.907	1.103	**-0.504**	0.038	-0.980	-0.028	0.907	1.103	-0.677	0.063	-1.391	0.037	0.907	1.103
Severity of infection																	
1.217	0.007	0.328	2.107	0.204	4.914	**1.437**	0.000	0.677	2.197	0.204	4.914	**1.268**	0.029	0.128	2.407	0.204	4.914
Have you been in quarantine?																	
0.855	0.051	-0.002	1.713	0.645	1.550	**0.780**	0.037	0.047	1.512	0.645	1.550	-1.008	0.072	-2.107	0.090	0.645	1.550
Have you been vaccinated against COVID?																	
0.256	0.373	-0.308	0.819	0.885	1.130	0.444	0.071	-0.037	0.925	0.885	1.130	**-1.868**	0.000	-2.590	-1.147	0.885	1.130

4.5 Discussion

4.5.1 Study of Health-Related Quality of Life

4.5.1.1 Overall HRQoL of General Population

To the best of our knowledge, this study is one of few research that to analyze EQ-5D-5L data from a large, representative sample in Hungary during the COVID-19 pandemic. It contributes unique insights into HRQoL, which are critical for informing public health policies and healthcare resource allocation during and post-pandemic periods. The study involved collecting online questionnaire data and examining EQ-5D-5L dimensional responses and utility while controlling of a variety of sociodemographic and COVID-19-related variables.

The EQ-5D-5L descriptive system showed that the overall health status of Hungarians was good, with 37.3% selecting the 'full health' status (i.e., 11111). This figure is comparable to, or slightly lower than, those reported in other countries during the COVID-19 pandemic, such as Italy (34.7%) (Meregaglia *et al.*, 2022) and Estonia (33.4% and 48.0%) (Tamson *et al.*, 2022). The mean utility of the EQ-5D-5L was 0.866, which exceeds the result of a previous non-representative study (0.751) conducted in Hungary during the pandemic (Szabo *et al.*, 2020). Comparable means were reported in various countries, with lower utilities in Uganda (0.570) (Violato *et al.*, 2023), Australia (0.718) (Violato *et al.*, 2023), Brazil (0.771) (Violato *et al.*, 2023), Sweden (0.78) (Chen *et al.*, 2023), Norway (0.78) (Chen *et al.*, 2023), Belgium (0.79) (Van Ballegooijen *et al.*, 2021), Canada (0.82) (Wen *et al.*, 2022), Denmark (0.82) (König *et al.*, 2023), the United States (0.82) (Chen *et al.*, 2023), Colombia (0.83) (Violato *et al.*, 2023), the United Kingdom (0.83) (König *et al.*, 2023), the Netherlands (0.84) (Van Ballegooijen *et al.*, 2021), Germany (0.85) (König *et al.*, 2023), Estonia (0.859) (Tamson *et al.*, 2022), and Morocco (0.86) (Azizi *et al.*, 2020). Conversely, higher utilities were observed in Finland (0.914) (Gamberini *et al.*, 2021), Portugal (0.92) (König *et al.*, 2023), Italy (0.928) (Gamberini *et al.*, 2021), France (0.94) (König *et al.*, 2023), Vietnam (0.95) (Vu *et al.*, 2020), and China (0.96) (Ping *et al.*, 2020). However, cross-country comparisons should be made with caution. The self-reported health status provided by the EQ-5D can be influenced by various factors, including variations in study design, national cultural norms, or religious perspectives. These factors may affect the reliability and generalizability of such comparisons (Bailey and Kind, 2010). For instance, variations in study design, such as sampling

techniques and the timing of data collection relative to the pandemic waves, could skew results. A more detailed understanding of these factors is essential for accurately interpreting the comparative data accurately and for applying the EQ-5D-5L tool effectively across diverse contexts. Additionally, the implications of these utility values for individual well-being and healthcare decisions warrant further investigation. For example, how might a decrease in utility scores influence health policy adjustments or resource allocation in response to a pandemic? Exploring these questions could provide practical insights into the utility of EQ-5D-5L scores. In light of these findings, we recommend that future research include longitudinal studies to track changes in HRQoL over time, as well as comparative studies across different demographic groups within Hungary. Such studies could help elucidate the long-term effects of the pandemic and contribute to a nuanced understanding of the determinants of HRQoL. This discussion is consistent with the broader conclusions of our dissertation and highlights the importance of robust, culturally sensitive research methods in understanding health outcomes during unprecedented global health crises.

4.5.1.2 HRQoL Based on EQ-5D-5L Dimension Responses

According to the EQ-5D-5L descriptive system, respondents in this research frequently reported problems primarily in the pain/discomfort dimension (47.4%), followed by mobility (33.3%) and the anxiety/depression dimension (32.8%). Similar trends are observed globally. In Portugal, during the COVID-19 quarantine, 37.7% of quarantined individuals reported pain/discomfort and 59.3% experienced anxiety/depression (Ferreira *et al.*, 2021a). In China, employees during the pandemic reported significant mental health burdens, with 55% indicating problems with anxiety/depression, higher than in the pre-pandemic period (Wong *et al.*, 2022). Meanwhile, in Iran, among COVID-19 patients discharged from hospitals, moderate impacts were observed across all dimensions, particularly anxiety/depression (58.74%) and pain/discomfort (42.03%) (Arab-Zozani *et al.*, 2020). In Morocco, during the COVID-19 home confinement, significant changes in HRQoL were observed. The EQ-5D-5L survey highlighted that anxiety/depression problems increased markedly, impacting 56% of the population under confinement (Azizi *et al.*, 2020). This was attributed to restricted daily activities and increased sedentariness due to home confinement measures, which disproportionately affected mental health and physical comfort. Respondents who had previously been infected with COVID-19 or had an

infected family member in the same or separate household were slightly more likely to report problems in the anxiety/depression and pain/discomfort dimensions compared to the uninfected population. This finding is consistent with other research showing that respondents with a history of COVID-19 infection are more likely to report problems in the anxiety/depression and pain/discomfort domains (Arab-Zozani *et al.*, 2020, Halpin *et al.*, 2021).

These findings illustrate the diverse impacts of COVID-19 on specific health dimensions across different populations and highlight the need for tailored healthcare interventions. It is crucial to differentiate between the effects observed in the general population and those experienced by specific groups under different conditions, such as quarantine or post-infection scenarios. Understanding these differences is essential for tailoring public health responses and interventions to address the varied impacts of the pandemic on different segments. Additionally, differences in reported health problems between countries may be influenced by several factors, including differences in healthcare systems, national pandemic response strategies, cultural perceptions of health issues, and the prevalence of the virus during the study periods. Understanding these factors is crucial for interpreting global differences in HRQoL outcomes and may provide insights for tailored health interventions. The increased incidence of anxiety and depression in several countries underlines the psychological toll of the pandemic. This increase may be due to social isolation, economic uncertainty, and fear of the virus. Understanding these causal relationships may help design targeted mental health interventions to mitigate the pandemic's impact on subjective well-being. When analyzing EQ-5D-5L data, it is important to consider potential biases from self-reporting, particularly in different cultural contexts where expressions of distress or psychological distress may vary. Additionally, the methods used to collect the data in different countries may affect the reliability and comparability of the results.

4.5.1.3 HRQoL Based on Socio-demographic Characteristics and COVID-19-related Characteristics

This study confirmed the assumptions in the existing literature regarding the association between sociodemographic factors and HRQoL during the COVID-19 pandemic. The analysis of EQ-5D-5L utility values showed a consistent decrease with increasing age (ranging from 0.919 to 0.796), except for the 35-44 years (0.915) and

65+ years (0.855) age groups. Notably, younger individuals reported higher EQ-5D-5L utility values than older counterparts, regardless of infection status, although the differences were marginal (Azizi *et al.*, 2020). Additionally, EQ-5D-5L utility values were slightly higher for men (0.883) compared with women (0.851) across each age group (Azizi *et al.*, 2020, Ferreira *et al.*, 2021a). When examining socioeconomic variables, participants who were full-time employed (0.916) reported the highest health status. Higher education and monthly income also significantly associated with higher utility values, aligning with findings from other studies (Tamson *et al.*, 2022).

The results of this study provide important benchmarks for surveys of individuals with a history of COVID-19 infection. These benchmarks facilitate assessment and allow HRQoL to be estimated relative to the general population. Notably, the overall EQ-5D-5L utility for respondents with previous COVID-19 experience (0.885) in this study was higher than utility values reported in previous studies from several countries, including Brazil (0.80) (Todt *et al.*, 2021), Pakistan (0.84) (Iqbal *et al.*, 2021), Mexico (0.85) (Ordinola Navarro *et al.*, 2021), Italy (0.85) (Gamberini *et al.*, 2021), France (0.860) (Garrigues *et al.*, 2020), and Iran (0.612) (Arab-Zozani *et al.*, 2020). Within this subgroup, there was a clear association between symptom severity and decreased utility, with those requiring hospital or ICU care reporting the lowest utility (0.679), contrasting the highest utilities reported in those with no symptoms (0.929). These findings are consistent with previous studies conducted in different regiones, such as the United Kingdom (Halpin *et al.*, 2021), Iran (Arab-Zozani *et al.*, 2020), Brazil (Todt *et al.*, 2021), and France (Garrigues *et al.*, 2020). These studies demonstrated a negative relationship between symptom severity and utility, with reported utilities ranging from 0.693 (ICU admission) to 0.724 (ward admission), 0.581 (ICU admission) to 0.613 (no ICU admission), 0.801 (with COVID-19 infection) to 1.000 (without COVID-19 infection), and 0.82 (ICU admission) to 0.86 (ward admission), respectively. These consistent patterns underscore the robustness of the observed negative relationship between symptom severity and utility, highlighting the broad applicability of these findings across contexts and regions.

The results of this study indicated that participants who underwent quarantine reported lower EQ-5D-5L utility (0.862) than those not quarantined (0.883). These results are consistent with published studies conducted in Portugal (0.861 vs. 0.887) (Ferreira *et al.*, 2021a), Morocco (0.86 vs. 0.91) (Azizi *et al.*, 2020), Vietnam (0.93 vs. 0.95), and China (0.93 vs. 0.96) (Vu *et al.*, 2020, Guo *et al.*, 2020). This consistency

supports the observation that quarantine negatively impacts HRQoL. Furthermore, vaccinated individuals (0.871) had slightly higher utility than unvaccinated individuals (0.856). Our results are consistent with studies from the USA (0.903 vs. 0.859) (Di Fusco *et al.*, 2022) and Japan (0.885 vs. 0.845) (Kamata *et al.*, 2023).

This analysis raises several important considerations. First, it emphasizes the need for targeted interventions to enhance HRQoL among vulnerable populations, such as the elderly and unvaccinated. It also prompts a deeper inquiry into the underlying reasons behind the disparities observed, such as potential cultural, economic, or healthcare system influences. Further research should explore the long-term impact of COVID-19 on HRQoL across different socioeconomic groups and evaluate the effectiveness of public health interventions designed to mitigate these impacts. In light of these findings, policymakers should consider the co-administration of influenza and COVID-19 vaccines, as recommended by the WHO and over twenty European countries (Janssen *et al.*, 2022), which could significantly enhance public health outcomes during pandemics. Future studies should also address the limitations noted in the current research, such as potential biases in survey methodology and challenges in generalizing EQ-5D-5L instrument results across different cultural contexts (Byambasuren *et al.*, 2023, Notarte *et al.*, 2022).

4.5.2 Study of Life Satisfaction

4.5.2.1 Distribution of Anxiety and Depression Symptoms and Level of Life Satisfaction

The present study contributes to recent literature on the impact of the COVID-19 pandemic on mental health and subjective life satisfaction by providing novel evidence from a broadly representative population in Hungary. Understanding the influence of protective and risk factors on anxiety, depression, and life satisfaction during such a crisis is crucial, as these factors shape public health responses and individual coping mechanisms.

The findings indicate a considerable prevalence of mental health issues and life dissatisfaction among Hungarians during the pandemic. Specifically, 41.5% reported anxiety (7.1% severe anxiety, 9.2% moderate anxiety, 25.3% mild anxiety; GAD-7 > 5), 48.1% reported depression (4.4% severe depression, 7% moderate severe depression, 10.2% moderated depression, 26.6 mild depression; PHQ-9 > 5), and 41.9% were dissatisfied with their life (11.6% extremely dissatisfied, 13.2% dissatisfied, 17.1%

slightly dissatisfied, 5.6% neutral; SWLS 5-20). These figures highlight the significant impact of the pandemic on well-being, underlining the need for effective mental health interventions and support systems. The distribution of anxiety, depressive symptoms, and level of subjective life satisfaction are shown in Figure 3.

Almost half of the participants showed symptoms of anxiety and depression and reported life dissatisfaction during the pandemic, underscoring its significant impact on SWB. The scarcity of similar studies in Hungary, particularly those reporting population-level prevalence, underscores the importance of our findings, making them particularly valuable for public health officials and policymakers. For comparative context, a study conducted by Valentina N. Burkova et al. (Burkova *et al.*, 2022) reported 28% mild, 10% moderate, and 5% severe anxiety symptoms during the pandemic in Hungary. Additionally, the mean SWLS score in this study (M=20.25) was slightly lower than that reported in studies from other countries following the spread of COVID-19. Specifically, Thailand reported a mean score of 22.4 (Sirinya Phulkerd et al. (Phulkerd *et al.*, 2023)), Poland reported a mean score of 22.67 (Joanna Dymecka et al. (Dymecka *et al.*, 2021)), and Italy reported a mean score of 21.32 (Pasquale Ricci et al. (Ricci *et al.*, 2023)), suggesting a potentially greater impact of the pandemic on life satisfaction in Hungary.

To increase the reliability of our findings, we included only data collected during the pandemic and used consistent measurement tools across the study. This methodological consistency ensures comparability but may limit generalizability to different pandemic phases or responses. Future research could extend this by including longitudinal data to observe changes over time or by comparing the effectiveness of different public health strategies. The high levels of dissatisfaction and mental health problems identified suggest that targeted public health interventions are urgently needed. These should aim to address the specific mental health and life satisfaction challenges identified, focusing on the most affected groups. Policymakers should consider coordinating mental health support with other public health interventions to effectively mitigate the impact of the pandemic.

4.5.2.2 Correlations, Differences and Predictors Based on Socio-demographic

The results indicated a nuanced understanding of the association between age and SWLS. Contrary to typical expectations, the oldest age group had SWLS scores second only to the 18-24 age group, providing an innovative perspective on the

association between age and SWLS. This finding is consistent with a previous study in Thailand conducted by S. Phulkerd et al. (Phulkerd *et al.*, 2023), which reported that older participants were more likely to have higher life satisfaction than their younger counterparts during the pandemic. This may be explained by the fact that the older generation has more experience and more time to develop a lifestyle that helps them cope. Additionally, Hungary has social and health services for the elderly, such as health insurance provided by the National Institute of Health Insurance Fund Management, which can help ease the financial burden and improve the daily lives of older citizens.

This research also showed that being female, single, and having lower levels of education and income were negatively associated with anxiety, depression, and life satisfaction among Hungarians. Women were more likely than men to report experiencing more mental health problems during the pandemic (Liu *et al.*, 2020). In this study, women showed mild anxiety and depression with significantly higher mean differences and were more likely to report mental health problems than men. This aligns with the findings of Hadis Amiri et al. (Amiri *et al.*, 2023), who found that COVID-19 had a more pronounced impact on life satisfaction among women. As studies have indicated that women are psychologically more skeptical and fearful of the consequences of COVID-19 or full recovery from this disease, this finding seems logical (Broche-Pérez *et al.*, 2022, Laufer and Shechory Bitton, 2021). Marital status played a pivotal role, with single individuals reporting the lowest life satisfaction and the highest anxiety and depression symptoms. Conversely, married participants had the best life satisfaction and better mental health, potentially due to the emotional and economic support inherent in committed relationships (Diener *et al.*, 2000, Gove *et al.*, 1983).

As expected, our results indicated that poor economic conditions and lower educational levels during the COVID-19 pandemic were associated with severe anxiety and depression symptoms and lower SWLS scores. Our findings are consistent with recent reports showing that the negative effects of the COVID-19 pandemic on mental health and subjective well-being disproportionately affect economically and educationally disadvantaged groups (Pieh *et al.*, 2020, Passos *et al.*, 2020). Researchers have proposed that such economic hardship leads to a much higher prevalence of mental health problems, including feelings of depression and anxiety (Witteveen and Velthorst, 2020) even pre-pandemic. Therefore, governments,

stakeholders, and organizations should consider financial support for vulnerable people, not only in the current situation but also for future prevention strategies.

The study results highlight that participants who are not working have more severe anxiety and depression symptoms, with students having the worst mental health status of all. Zhang et al. (Zhang *et al.*, 2020) conducted a study to assess the health, distress, and life satisfaction of working adults one month after the outbreak of COVID-19 in China, founding that employees who stopped working had worse mental and physical conditions and higher distress. In general, returning to normal working conditions during the COVID-19 pandemic could increase life satisfaction. It seems that even under the fear of contracting an infectious disease, stopping work could have negative psychological consequences. Another study showed that having a dynamic work environment during the COVID-19 outbreak could improve life meaning and life satisfaction. Therefore, it seems that returning to a dynamic work environment after recovering from COVID-19 could have positive psychological effects, such as increased life satisfaction (Trzebiński *et al.*, 2020). Thus, the results of this study also confirmed these findings, showing that unemployed participants had lower life satisfaction scores and more severe health problems.

In light of these findings, it is imperative that governments and stakeholders implement targeted financial and social support strategies, not only to mitigate the current impact but also to prepare for future public health crises. In particular, policies aimed at supporting mental health services, increasing employment opportunities, and providing financial support to the most vulnerable populations are crucial. Further research is needed to explore the long-term impact of the pandemic on different demographic groups. Longitudinal studies could provide deeper insights into the persistence of these mental health trends and the effectiveness of the interventions implemented.

4.5.2.3 Correlations, Differences and Predictors Based on COVID-19-related Characteristics

The results showed that participants who had experienced COVID-19 infection or quarantine reported unexpectedly higher life satisfaction. This contrasts with prior studies, such as those by researchers (Trzebiński *et al.*, 2020), which identified a negative association between COVID-19 infection and mental health. Our findings confirm the importance of COVID-19 experiences in increasing perceived levels of

mental health problems (Zheng, 2020). Given the significant impact of COVID-19 on mental health, the impact of mental health on life satisfaction, the impact of COVID-19 on life satisfaction could be explained. In other words, contracting COVID-19 typically decreases life satisfaction. However, our research does not align with this finding. This discrepancy may be because participants rated their life satisfaction based on their current and past feelings. Additionally, individuals who recovered from COVID-19 and returned to work were relatively satisfied with themselves and their lives. Previous research has shown that traumatic experiences such as COVID-19 infection can lead to positive reactions (Finstad *et al.*, 2021). Previous studies have revealed that recovery from the disease positively affects life satisfaction (Laudet and White, 2008, van Koppenhagen *et al.*, 2009).

The study also explored the impact of COVID-19 vaccination on mental health. Vaccinated participants reported lower levels of psychological distress and higher life satisfaction compared to their unvaccinated counterparts. This aligns with findings from the United States and Spain, where vaccination was associated with decreased perceived risk of severe illness and psychological distress (Koltai *et al.*, 2022, Montero-López *et al.*, 2022). These results reflect and confirm the positive effects of the COVID-19 vaccine on Hungarian life satisfaction.

We used robust statistical methods to analyze the impact of COVID-19 on life satisfaction and mental health, controlling for various sociodemographic factors. The results were statistically significant, suggesting strong associations between COVID-19 experience, vaccination status, and mental health outcomes. Our research contradicts typical findings that associate viral infection with reduced life satisfaction. This discrepancy could be due to differences in the study populations, timing of data collection, or cultural factors in coping mechanisms. It highlights the complexity of the impact of COVID-19 on mental health and the potential for variable responses depending on individual and societal factors. These findings have important implications for public health strategies. They suggest that strengthening support systems during recovery, promoting effective communication about the benefits of vaccination, and ensuring access to mental health resources are essential to improving life satisfaction and reducing distress during pandemics. Future studies should examine the longitudinal effects of COVID-19 to understand the lasting impact of the pandemic on mental health and life satisfaction. Research should also examine the

mechanisms by which vaccination affects psychological well-being, to inform public health messaging.

The results of this study provide a nuanced understanding of the interplay between COVID-19 experiences and life satisfaction. They challenge some existing assumptions and deepen our understanding of the impact of the pandemic on mental health, highlighting the importance of targeted interventions to mitigate negative outcomes and improve overall subjective well-being (SWB).

4.6 Conclusions

4.6.1 Study of Health-Related Quality of Life

This study provides the first comprehensive analysis using the EQ-5D-5L instrument to assess HRQoL in relation to sociodemographic and COVID-19-related factors in Hungary, utilizing a large sample of adults during the pandemic. Our analysis showed that while a history of COVID-19 infection generally had no significant impact on HRQoL for most participants, individuals who experienced severe infections requiring hospitalization or intensive care unit (ICU) care reported a long-term negative impact. This suggests that the severity of the infection plays a critical role in determining long-term health outcomes. Additionally, respondents who had personally experienced COVID-19 or had a family member affected by the virus reported higher incidences of anxiety and depression. This increase in mental health problems may be due to the psychological stress of illness, quarantine, and the economic and social stresses associated with the pandemic. Comparatively, the effects observed in Hungary are in line with global trends, where COVID-19 infection with symptoms has resulted in a significant decline in HRQoL. This underscores the effectiveness of Hungarian public health messaging and healthcare support during the pandemic. Future research should focus on longitudinal studies to track the evolution of HRQoL impacts over time, particularly after recovery from COVID-19. Comparative studies between different healthcare systems could also provide insights into effective public health management strategies during pandemics.

4.6.2 Study of Life Satisfaction

The second case of life satisfaction examines the prevalence and predictors of anxiety, depression, and life satisfaction levels in a sample of adult Hungarians during the pandemic, providing important insights into the mental health landscape. Notably, almost half of the participants showed symptoms of anxiety and depression, and a significant proportion also reported dissatisfaction with their lives during the

pandemic. This underscores the profound impact of the pandemic on well-being and highlights the urgent need for effective interventions. The research identifies age, marital status, net monthly income, severity of infection, and quarantine status as significant predictors of anxiety and depression. Additionally, experience of COVID-19 and severity of infection were significant predictors of life satisfaction. These findings suggest that economic improvement, support for the unmarried population, enhanced psychological health and subjective well-being of young individuals, protection from COVID-19 infection, and treatment of COVID-19 symptoms can alleviate psychological problems and improve life satisfaction during the pandemic.

The implications of this study are broad and significant. It provides the government and other stakeholders with a better understanding of the factors affecting life satisfaction among Hungarians during the pandemic. Addressing these factors has the potential to significantly improve subjective well-being, especially among the most vulnerable groups. In addition to documenting mental health issues during the pandemic in Hungary, the study provides a comparative analysis that places these findings in a broader international context. This comparison is crucial as it highlights commonalities and differences across borders, providing a more comprehensive understanding of the global impact of the pandemic on mental health. In conclusion, this study makes a significant contribution to our understanding of the socio-demographic impact on mental health during COVID-19. By integrating these findings with international data, the study not only contextualizes the Hungarian experience, but also enriches the global discourse on the effective management of public health crises.

5 Limitation in This Dissertation

Although this study identified significant predictors for HRQoL, life satisfaction, and mental health, several limitations were encountered. Firstly, this study was cross-sectional, which precludes making any causal inferences. Therefore, we cannot definitively comment on how the COVID-19 pandemic may have affected or modified these results. In addition, data collection used questionnaires which depend on individual's ability to remember their past experience, e.g., 'Over the last 2 weeks, how often have you been bothered by any of the following problems?'. Recall bias could cause either overestimation or underestimation of the various indicators and variables. Meanwhile, it is important to note that our study lacked information regarding the time interval between individuals' COVID-19 infection and their completion of the questionnaire. The absence of this information may limit our understanding of the potential long-term impacts on HRQoL, life satisfaction, and mental health. Furthermore, our study lacked access to data concerning individuals who died as a result of COVID-19, limiting our ability to obtain valuable insights into the overall health outcomes and subjective well-being associated with the COVID-19 pandemic. Thus, the average values of the EQ-5D-5L utility, anxiety and depression symptoms, and life satisfaction scores are likely to be overestimated. Moreover, as this study was conducted online, it was accessible from any computer or mobile device. During the COVID-19 pandemic, individuals without internet access may have been at greater risk of experiencing lower SWLS scores. This highlights the necessity of addressing inequality concerns regarding access to technology (Harris *et al.*, 2017). Finally, participants who had been infected with COVID-19 accounted for less than 20% of the total respondents, and only ten participants were hospitalized, indicating potential bias.

6 Answer to the Hypotheses

Hypothesis 1: Individuals who have had COVID-19, especially those with severe symptoms or hospitalizations, will report lower HRQoL compared to those who have not been infected.

The results support this hypothesis, indicating that respondents with previous COVID-19 infection reported significantly fewer problems in the mobility and usual activities dimensions, suggesting a nuanced impact on HRQoL. However, severe symptoms of COVID-19 infection were associated with an increased frequency of problems in the mobility and pain/discomfort dimensions, highlighting the negative impact of severe infections on HRQoL. This suggests that while COVID-19 infection has an impact on HRQoL, the severity of symptoms plays a crucial role in determining the extent of this impact.

Hypothesis 2: COVID-19 infection status will influence the reporting of problems in all EQ-5D-5L dimensions, with previously infected individuals being more likely to report problems in dimensions such as mobility and usual activities due to the lingering effects of the virus on physical health.

The results also support the hypothesis. The analysis showed that the likelihood of experiencing ‘any problems’ (level 2-5) across the EQ-5D-5L dimensions differed between previously infected and uninfected individuals, particularly in the mobility and usual activities dimensions. This suggests that COVID-19 infection status does influence HRQoL, with previously infected individuals reporting varying levels of problems. However, the expectation that previously infected individuals would consistently report more problems was not fully met, as they reported slightly lower percentages of ‘any problems’ in most dimensions except for anxiety/depression. This may suggest that while physical health effects may be less pronounced or reversible, psychological effects may be more persistent or pronoumced.

Hypothesis 3: Older age groups are expected to report more problems across all dimensions of HRQoL compared to younger age groups, reflecting the impact of aging on physical health. Additionally, gender differences are expected. This assumed that age and gender may have significant and distinct effects on HRQoL during the COVID-19 pandemic.

The results support the hypothesis that aging has a significant impact on HRQoL, with older people reporting more problems in the physical health dimensions. This is consistent with the expected age-related decline in HRQoL. Additionally, the finding

that male participants reported fewer problems in certain dimensions supports the hypothesis of gender differences in health perception or resilience.

Hypothesis 4: Socioeconomic factors have a significant impact on HRQoL during the COVID-19 pandemic, we assumed that with higher socioeconomic status being associated with better HRQoL.

The analysis supports the importance of socioeconomic factors, confirming the hypothesis. Employment status, education, and income level are important determinants of HRQoL. Unemployment, part-time employment, and lower socioeconomic status are negatively associated with HRQoL, while higher education and income levels have a positive impact on HRQoL.

Hypothesis 5: Experiences related to COVID-19, such as severity of infection, quarantine and vaccination status, differentially affect HRQoL. Severe infections, quarantined and vaccinated status lead to lower HRQoL.

The results partially confirm the hypothesis. Severe COVID-19 infection (requiring hospital or intensive care unit care) significantly detracts from HRQoL ($\beta = -0.251$, $p < 0.001$), consistent with the expectation that more severe health consequences of COVID-19 lead to worse HRQoL. However, general COVID-19 infection, quarantine, and vaccination status did not have a direct significant effect on HRQoL as hypothesized. This suggests that while specific severe experiences with COVID-19 do affect HRQoL, broader experiences such as simply having COVID-19, undergoing quarantine, or vaccination status may not have a direct effect on overall HRQoL or may have effects that are offset by other factors.

Hypothesis 6: Age, marital status and socioeconomic status (including educational level and net monthly income) significantly influence life satisfaction during the COVID-19 pandemic.

The results confirm the hypothesis but reveal a U-shaped pattern in life satisfaction across age groups, with higher dissatisfaction among the middle-aged and higher satisfaction among the youngest and oldest groups. Single people report lower life satisfaction, highlighting the positive impact of companionship. Higher levels of education and income are associated with increased life satisfaction, emphasizing the role of socio-economic factors.

Hypothesis 7: Direct COVID-19 experience (severity of infection, quarantine status, and vaccination status) will significantly affect levels of anxiety and depression.

Severe COVID-19 infection, quarantined and vaccinated status are expected to be associated with increased levels of anxiety and depression.

Contrary to the hypothesis, direct COVID-19 experience and quarantine status did not significantly affect anxiety levels, suggesting that these factors alone may not predispose individuals to higher levels of anxiety. However, severe COVID-19 symptoms and the need for hospital or intensive care were associated with higher levels of anxiety and depression, partially supporting the hypothesis. Additionally, not being vaccinated against COVID-19 is associated with higher levels of anxiety, consistent with the hypothesis that vaccination status affects mental health.

Hypothesis 8: Direct experiences of COVID-19, such as severity of infection and quarantine, will have nuanced effects on life satisfaction. It is expected that more severe COVID-19 infections and the experience of quarantine will exacerbate the impact on life satisfaction may reveal complex patterns, possibly indicating resilience or adaptation in some individuals.

The results also support the hypothesis of a nuanced impact of COVID-19 experiences on mental health and life satisfaction. Specifically, the severity of COVID-19 infection and quarantine were associated with increased depression and anxiety scores, highlighting the mental health burden of severe illness and isolation measures. Interestingly, COVID-19 infection was associated with lower life satisfaction, but an increase in the severity of infection was paradoxically associated with slightly higher life satisfaction. This counterintuitive finding suggests a complex relationship between the experience of COVID-19 and how individuals assess their overall life satisfaction, possibly indicating a sense of resilience or adaptation.

7 Summary

This comprehensive analysis successfully unraveled the complex interplay between sociodemographic factors, COVID-19 experience, and their cumulative impact on HRQoL, anxiety, depression, and life satisfaction among the Hungarian population during the COVID-19 pandemic. Contrary to initial hypotheses, previous COVID-19 infection did not significantly alter HRQoL. However, severe cases requiring hospitalization or ICU care were associated with long-term adverse effects on HRQoL, particularly worsening problems in the anxiety/depression dimension of EQ-5D-5L. Additionally, nearly half of the participants reported symptoms of anxiety and depression, highlighting the profound psychological toll of the pandemic. The predictors identified such as age, marital status, income, severity of infection, and quarantine status, highlight the differential impact of the pandemic on different demographic segments. The findings argue for increased economic support, focused attention on unmarried and younger populations, and robust interventions against COVID-19 infection to alleviate psychological distress and promote life satisfaction. Ultimately, the findings provide critical evidence and underscore the need for informed, targeted action to improve the HRQoL and SWB of the Hungarian population in these unprecedented times. These normative values, derived from a nuanced understanding of the multiple effects of COVID-19, are essential for monitoring population health, informing healthcare decisions, and ensuring community resilience to current and future public health challenges.

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Achievement

List of Conferences

Conference	The topics I presented and/or published in conference
ISPOR Europe 2022	• 673 Cost-of-illness of adult atopic dermatitis in Hungary • EPH99 Determinants of COVID-19 Vaccination in Hungary, Results of a Large Cross-Sectional Online Survey • HTA65 Socio-Economic Determinants of Health Status During COVID-19 Pandemic in Hungary
EuHEA PhD Student Supervisor Conference 2023	• Analysis of the Socio-determinants of the Health-related Quality of Life of Older Adults in Hungary during COVID-19 Based on the Conceptual Framework for Health Determinants
ISPOR Europe 2023	• HTA151 Subjective Well-Being and Mental Health during the COVID-19 Pandemic in Hungary

List of Publication

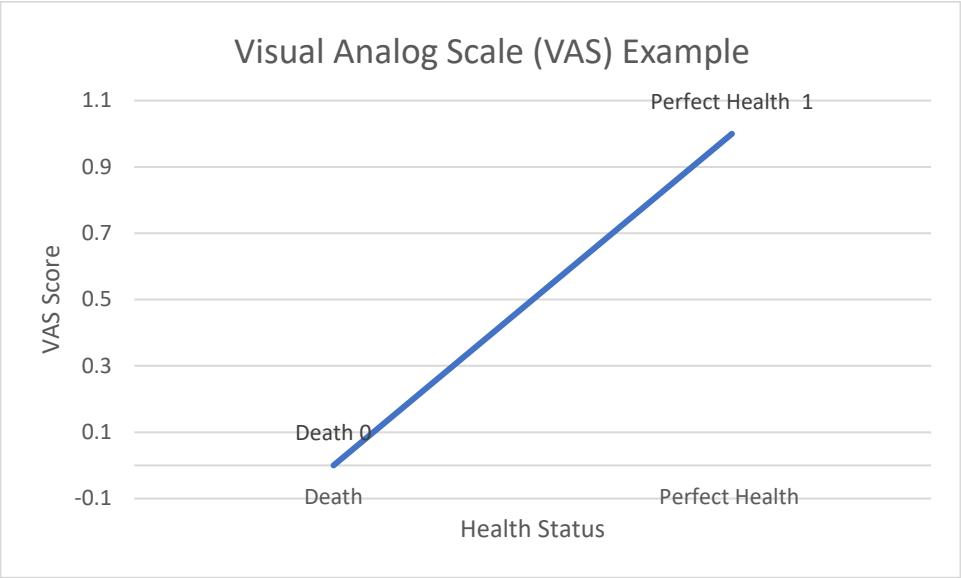
Author	Title	Author	Journal
Co-Author			
	• Societal costs and health related quality of life in adult atopic dermatitis	Zsuzsanna Beretzky, Kamilla Koszorú, Fanni Rencz, Krisztina Hajdu, Júlia Borza, Katalin Bodai, ***Xu Feifei***, Andrea Szegedi, Miklós Sárdy & Valentin Brodszky. Societal costs and health related quality of life in adult atopic dermatitis. BMC Health Serv Res 23, 859 (2023).	BMC Health Services Research is a prestigious, open-access journal ranked in Quartile 1 (Q1)

	https://doi.org/10.1186/s12913-023-09840-7	
First Author		
• Subjective Well-Being and Mental Health During the COVID-19 Pandemic in Hungary DOI: 10.1108/MHSI-10-2024-0178 <Mental Health and Social Inclusion>	***Xu, F***. (2024). Subjective well-being and mental health during the COVID-19 pandemic in Hungary. Mental Health and Social Inclusion.	Mental Health and Social Inclusion is an international, peer-reviewed Q3 journal, dedicated to promoting the social inclusion of individuals with mental health conditions.
• The Impact of COVID-19 on Health-Related Quality of Life: A Systematic Review and Evidence-Based Recommendations DOI: https://doi.org/10.1007/s44202-024-00204-8 <Discov Psychol >	***Xu, F***., & Brodszky, V. (2024). The impact of COVID-19 on health-related quality of life: a systematic review and evidence-based recommendations. Discover Psychology, 4(1), 90.	Discover Psychology Journal is an open-access journal available on SpringerLink
• Socioeconomic Determinants of Health-related Quality of Life During COVID-19 pandemic in Hungary: a large cross-sectional representative survey		Under Review
• Understanding the Determinants of Health-related Quality of Life in Elderly Hungarians: A Structural Equation Modeling Approach Amidst COVID-19		Under Review
• Subjective Well-Being Amidst the COVID-19 Pandemic: In-sights from a Literature Review Using the SWLS and Meta-Analysis		Under Review

Appendix

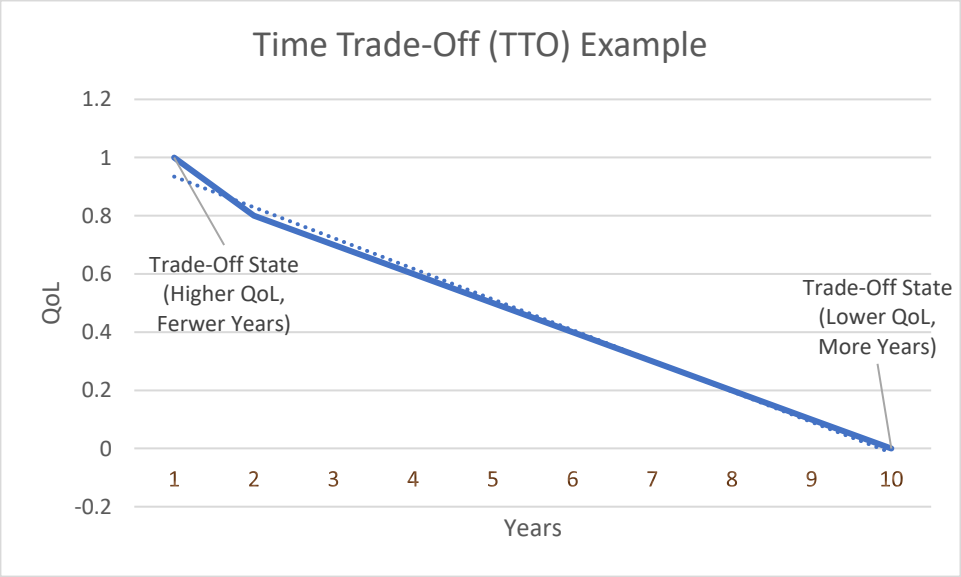
Direct Methods Used in Assessment of HRQoL

Visual Analogue Scales



Note: The graph above illustrates the concept of a Visual Analog Scale (VAS) as used in health economics and quality of life research. It represents a simple linear scale ranging from 0, denoting death, to 1, signifying perfect health. Respondents are asked to place a mark on the scale that best represents their current health state or their valuation of hypothetical health states, providing a direct measure of health-related quality of life or preferences. This method allows for a straightforward interpretation of an individual's health status or preferences across a continuum of health states.

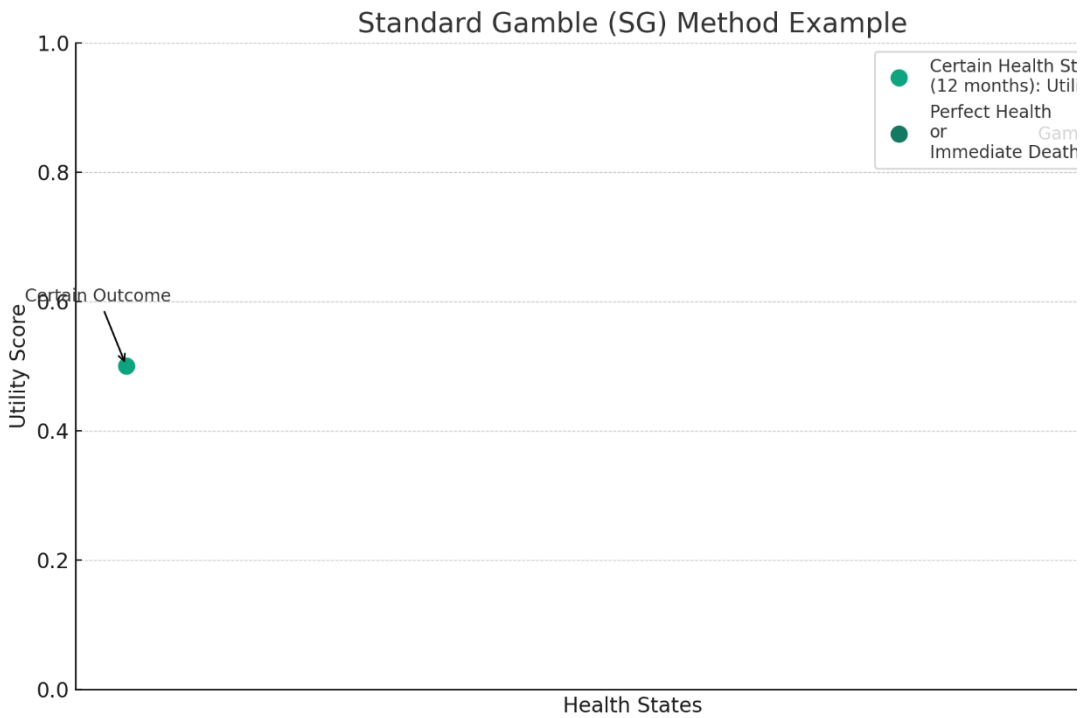
Time Trade-Off (TTO)



Note: The graph above illustrates the Time Trade-Off (TTO) method conceptually. It depicts a scenario where an individual must choose between a longer duration of life with a lower quality of

life (QoL) and a shorter life span with optimal well-being. The points indicate two states: the current state with more years but lower QoL, and a hypothetical trade-off state where the individual opts for fewer years but higher QoL. This graphical expression helps to visualize the trade-offs individuals might consider when valuing different health states against each other.

Standard Gamble



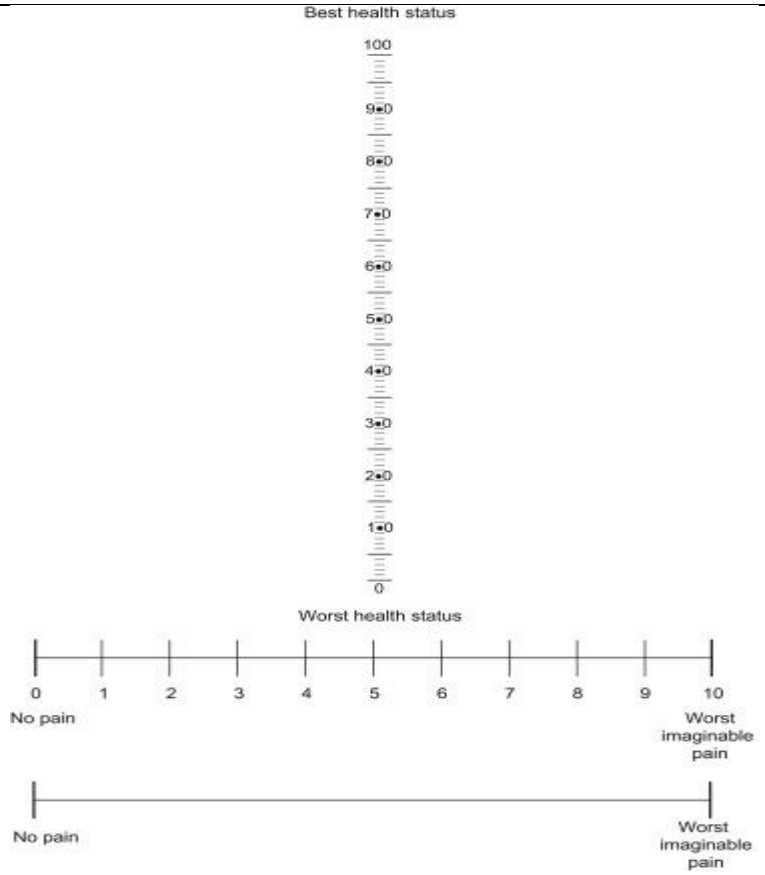
Note: The graph visually represents the Standard Gamble (SG) method, illustrating a scenario where participants choose between a certain health state for 12 months and a gamble between achieving perfect health or facing immediate death. The utility scores assigned to these options reflect the participants' valuation of the health states, with the gamble outcome typically associated with a higher utility score due to the possibility of achieving perfect health. This graphical expression aids in understanding the trade-offs and preferences individuals might have when faced with decisions under uncertainty in health outcomes.

Questionnaires

EQ-5D-5L (VAS)

EQ-5D-5L (UK English sample version)
Under each heading, please tick the **ONE** box that best describes your health **TODAY** MOBILITY
I have no problems in walking about □
I have slight problems in walking about □
I have moderate problems in walking about □
I have severe problems in walking about □
I am unable to walk about □
SELF-CARE
I have no problems washing or dressing myself □
I have slight problems washing or dressing myself □
I have moderate problems washing or dressing myself □
I have severe problems washing or dressing myself □
I am unable to wash or dress myself □
USUAL ACTIVITIES (e.g. work, study, housework, family or leisure activities)
I have no problems doing my usual activities □
I have slight problems doing my usual activities □
I have moderate problems doing my usual activities □
I have severe problems doing my usual activities □
I am unable to do my usual activities □
PAIN / DISCOMFORT I have no pain or discomfort □
I have slight pain or discomfort □
I have moderate pain or discomfort □
I have severe pain or discomfort □
I have extreme pain or discomfort □
ANXIETY / DEPRESSION
I am not anxious or depressed □
I am slightly anxious or depressed □

I am moderately anxious or depressed
I am severely anxious or depressed
I am extremely anxious or depressed
We would like to know how good or bad your health is **TODAY.**
This scale is numbered from 0 to 100. • 100 means the best health you can imagine. 0 means the worst health you can imagine.
Mark an X on the scale to indicate how your health is TODAY.
Now, please write the number you marked on the scale in the box below.
YOUR HEALTH TODAY =



EQ-5D Use guide. (chromeextension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.unmc.edu/centric/_documents/EQ-5D-5L.pdf)

PHQ-9

PHQ-9 Depression Scale

Over the last 2 weeks, how often have you been bothered by any of the following problems?	NOT AT ALL	SEVERAL DAYS	MORE THAN HALF THE DAYS	NEARLY EVERY DAY
1. Little interest or pleasure in doing things	○ 0	○ 1	○ 2	○ 3
2. Feeling down, depressed, or hopeless	○ 0	○ 1	○ 2	○ 3
3. Trouble falling or staying asleep, or sleeping too much	○ 0	○ 1	○ 2	○ 3
4. Feeling tired or having little energy	○ 0	○ 1	○ 2	○ 3
5. Poor appetite or overeating	○ 0	○ 1	○ 2	○ 3
6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down	○ 0	○ 1	○ 2	○ 3
7. Trouble concentrating on things, such as reading the newspaper or watching television	○ 0	○ 1	○ 2	○ 3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual	○ 0	○ 1	○ 2	○ 3
9. Thoughts that you would be better off dead, or of hurting yourself in some way	○ 0	○ 1	○ 2	○ 3

10. If you checked off any problems on this questionnaire so far, how difficult have these problems made if for you to do your work, take care of things at home, or get along with other people?			
Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
○ 0	○ 1	○ 2	○ 3

SCORING:

Each response from the PHQ9 has a score ranging from 0 to 3. The score for each response is next to the check box. After a patient has completed the PHQ9, add up each column score, and then sum all four columns for the patient's score. Below are the scoring guidelines for the PHQ9.

Scoring Guidelines

Guidelines for Interpretation of PHQ9*

Score	Risk Level	Intervention
0-4	No to Low risk	None, rescreen annually
5-9	Mild	Watchful waiting; repeat PHQ9 at follow up
10-14	Moderately	Treatment plan, considering counseling, follow-up and/or pharmacotherapy
15-19	Moderately Severe	Active treatment with pharmacotherapy and/or psychotherapy
20+	Severe	Immediate initiation of pharmacotherapy and if, severe impairment or poor response to therapy, expedited referral to a mental health specialist for psychotherapy and/or collaborative management

*Kroenke K, Spitzer RL. (2002). The PHQ-9: A new depression and diagnostic severity measure. *Psychiatric Annals*, 32, 509-521. *NOTE: If the patient responds to question 9 with any answer other than "not at all," a suicide risk assessment needs to be completed. If the total score is 10 or more, this could indicate a clinically significant problem and should trigger referral to a mental health program or enrollment in the Mental Health Integration Program.*

GAD-7

GAD-7 Anxiety Scale

Over the Last 2 weeks, how often have you been bothered by any of the following problems?	NOT AT ALL	SEVERAL DAYS	MORE THAN HALF THE DAYS	NEARLY EVERY DAY
1. Feeling nervous, anxious or on edge	○ 0	○ 1	○ 2	○ 3
2. Not being able to stop or control worrying	○ 0	○ 1	○ 2	○ 3
3. Worrying too much about different things	○ 0	○ 1	○ 2	○ 3
4. Trouble relaxing	○ 0	○ 1	○ 2	○ 3
5. Being so restless that it is hard to sit still	○ 0	○ 1	○ 2	○ 3
6. Becoming easily annoyed or irritable	○ 0	○ 1	○ 2	○ 3
7. Feeling afraid as if something awful might happen	○ 0	○ 1	○ 2	○ 3

8. If you checked off any problems on this questionnaire so far, how difficult have these problems made if for you to do your work, take care of things at home, or get along with other people?			
Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
○ 0	○ 1	○ 2	○ 3

SCORING:

Each response from the GAD7 has a score ranging from 0 to 3. The score for each response is next to the check box. After a patient has completed the GAD7, add up each column score, and then sum all four columns for the patient's score. Below are the scoring guidelines for the GAD7.

Scoring Guidelines

Guidelines for Interpretation for GAD7

Score	Risk Level	Intervention
0-4	No to Low risk	None, rescreen annually
5-9	Mild	Provide general feedback, repeat GAD7 at follow up
10-14	Moderate	Further Evaluation Recommended and referral to mental health program
15+	Severe	Further Evaluation Recommended and referral to mental health program

Spitzer RL, Kroenke K, Williams JB, et al; A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med. 2006 May 22;166(10):1092-7. GAD-7

If the total score is 10 or more, this could indicate a clinically significant problem and should trigger referral to a mental health program or enrollment in the Mental Health Integration Program.

Satisfaction with Life Scale (SWLS)

Below are five statements with which you may agree or disagree. Using the 1-7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.
The 7-point scale is: 1 =strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 =slightly agree, 6 =agree, 7 =strongly agree.

Satisfaction with Life Scale (SWLS)	Strongly Disagree	2	3	4 (Neutral)	5	6	Strongly Agree
1. In most ways, my life is close to my ideal.	1	2	3	4	5	6	7
2. The conditions of my life are excellent.	1	2	3	4	5	6	7
3. I am satisfied with my life.	1	2	3	4	5	6	7
4. So far, I have gotten the important things I want in life.	1	2	3	4	5	6	7
5. If I could live my life over, I would change almost nothing.	1	2	3	4	5	6	7

Scores consist of a raw score (between 5 and 35). Higher scores represent higher life satisfaction. Scorers can be assigned into six well-being categories and interpretative text in provided for each.

31 - 35 Extremely satisfied
26 - 30 Satisfied
21 - 25 Slightly satisfied
20 Neutral
15 - 19 Slightly dissatisfied
10 - 14 Dissatisfied
5 - 9 Extremely dissatisfied

Appendix Tables

Appendix Table 1 MEDLINE search strategy

	Search term (HRQoL)
1	quality adjusted life years
2	QALY
3	EQ-5D
4	euroqol
5	EQ5D
6	SF-6D
7	SF6D
8	“VAS” [Title/Abstract]
9	“VISUAL ANALOGUE SCALE”
10	Time trade off
11	Time trade-off
12	Timetradeoff
13	TTO
14	Standard Gamble
15	“SG” [Title/Abstract]
16	“Person tradeoff”
17	“Person trade-off”
18	PTO
19	preference based quality of life
20	“Health state utility value “
21	“Health state utilities value” [Title/Abstract]
22	“HSUV”
23	“Health state utility”
24	“Health state utilities”
25	“Health utility’’
26	“Health utilities”

	Search term (HRQoL)
27	15-dimensional questionnaire
28	15D
29	“health utility index”
30	“Health utilities index”
31	HUI[Title/Abstract]
32	HUI1
33	HUI2
34	HUI3
35	OR (‘1 to 34’) AND COVID-19

Supplementary Table of Health-Related Quality of Life Literature Review

Appendix Table 2 Supplemental table of HRQoL literatures

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
Halpin et al. 2021	Adult patients were infected by COVID-19 and discharged from hospital	EQ-5D-5L	Ward patients	68	0.724
			ICU patients	32	0.693
Garrigues 2020	French speaking patients who were hospitalized in COVID-19 ward unit more than 100 days after their admission and discharged at the time of study	EQ-5D-5L	Overall	120	0.860 (0.200)
			Ward group	96	0.860 (0.190)
			ICU group	24	0.820 (0.210)
Ping 2020	Non representative sample of the Changzhi city (China) population	EQ-5D-3L	Overall	1139	0.949 (0.102)
			Male	460	0.947 (0.108)
			Female	679	0.951 (0.098)
			Age--<18	36	0.963 (0.074)
			Age—18–29	271	0.975 (0.063)
			Age—30–39	322	0.963 (0.090)
			Age—40–49	276	0.953 (0.084)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Age—50–59	158	0.898 (0.150)
			Age—60+	76	0.889 (0.141)
			Marital status—Married	869	0.967 (0.107)
			Marital status—Unmarried	233	0.962 (0.081)
			Marital status—Divorced/widowed	38	0.944 (0.087)
			Employment status—Employed	693	0.957 (0.088)
			Employment status—Retired	106	0.886 (0.152)
			Employment status—Unemployed	340	0.954 (0.102)
			Chronic disease condition—No chronic disease	671	0.979 (0.053)
			Chronic disease condition—With one chronic disease	248	0.936 (0.112)
			Chronic disease condition—With two chronic diseases	112	0.916 (0.101)
			Chronic disease condition—With three or more chronic disease	108	0.828 (0.175)
			Education level—Primary school and below	203	0.948 (0.085)
			Education level—Junior middle school	256	0.946 (0.109)
			Education level—Senior middle school	346	0.954 (0.098)
			Education level—University and above	334	0.944 (0.112)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Family income (in the local)—Low	58	0.945 (0.133)
			Family income (in the local) —Lower	614	0.951 (0.099)
			Family income (in the local) —Middle	318	0.952 (0.106)
			Family income (in the local) —Higher	90	0.925 (0.091)
			Family income (in the local) —High	59	0.964 (0.072)
			Worry about got COVID-19—Very high	32	0.868 (0.220)
			Worry about got COVID-19—High	102	0.918 (0.124)
			Worry about got COVID-19—Low	484	0.948 (0.089)
			Worry about got COVID-19—Very low	521	0.962 (0.095)
			Epidemic effects—Yes	660	0.936 (0.116)
			Epidemic effects—No	479	0.968 (0.074)
Benítez 2020	Patients older than 60 diagnosed of amnesic mild cognitive impairment or mild AD that recruited from a single neurology center	EQ-5D-5L	Overall patients (before the 5 weeks of lock down)	NR	0.66
			Overall patients (after the 5 weeks of lock down)	NR	0.62
			Overall caregivers （before the 5 weeks of lock down）	NR	0.74
			Overall caregivers （after the 5 weeks lock down）	NR	0.72

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Alzheimer's disease (AD) patients (before the 5 weeks of lockdown)	NR	0.6
			Mild cognitive impairment (MCI) patients (before the 5 weeks of lockdown)	NR	0.72
			Alzheimer's disease (AD) patients (after the 5 weeks of lockdown)	NR	0.56
			Mild cognitive impairment (MCI) patients (after the 5 weeks of lockdown)	NR	0.69
			Caregivers for Alzheimer's disease (AD)patients (before the 5 weeks of lockdown)	NR	0.68
			Caregivers for Alzheimer's disease (AD) patients (after the 5 weeks of lockdown)	NR	0.65
			Caregivers for mild cognitive impairment (MCI) patients (before the 5 weeks of lockdown)	NR	0.8
			Caregivers for mild cognitive impairment (MCI) patients (after the 5 weeks of lockdown)	NR	0.79
Vu 2020	Non representative sample of Vietnam adult papulation	EQ-5D-5L	Overall	406	0.950 (0.080)
			Do not need isolation	339	0.950 (0.070)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			In government quarantine facilities	10	0.940 (0.120)
			Self-isolation at private place	57	0.930 (0.130)
Arab-Zozani 2020	Patients who were COVID-19 infection that had been discharged from the Shahid Sadoughi hospital	EQ-5D-5L	Overall	409	0.612 (0.006)
			ICU admission ward	74	0.581 (0.201)
			No ICU admission	335	0.613 (0.167)
			Duration of hospitalization (d) ≤ 10	222	0.591 (0.201)
			Duration of hospitalization (d)> 10	187	0.603 (0.167)
			Duration after hospital discharge (d) ≤ 14	34	0.602 (0.150)
			Duration after hospital discharge (d) 15-30	168	0.611 (0.271)
			Duration after hospital discharge (d) > 30	207	0.608 (0.121)
			Diabetes—Yes	262	0.586 (0.121)
			Diabetes –No	147	0.612 (0.107)
			Heart failure--- Yes	45	0.597 (0.157)
			Heart failure ---No	364	0.605 (0.131)
			Cholesterol—Yes	212	0.608 (0.101)
			Cholesterol –No	197	0.612 (0.167)
			Hypertension —Yes	245	0.590 (0.167)
			Hypertension--- No	164	0.609 (0.201)
Azizi 2020	Non representative sample in Moroccan Arabic dialect during of the home confinement	EQ-5D-5L	Overall (before confinement)	NR	0.910
			overall (during confinement)	NR	0.860
			Female (during the home confinement)	338	0.850 (0.190)
			Male (During the home confinement)	199	0.890 (0.150)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Marital status—widowed (during the home confinement)	4	0.530 (0.430)
			Marital status—single (during the home confinement)	270	0.870 (0.160)
			Marital status—married (during the home confinement	237	0.860 (0.180)
			Marital status—separated (during the home confinement)	26	0.890 (0.130)
			Education level —university (During the home confinement)	461	0.880 (0.160)
			Education level—secondary (during the home confinement)	57	0.800 (0.220)
			Education level—primary (during the home confinement)	14	0.730 (0.280)
			Education level—illiterate (during the home confinement)	5	0.670 (0.450)
			Profession—no occupation	92	0.810 (0.230)
			Profession—students	105	0.880 (0.160)
			Profession —worker	340	0.870 (0.160)
			Number of children (0) (During the home confinement)	310	0.870 (0.160)
			Number of children (1-4) (During the home confinement)	178	0.870 (0.150)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Number of children (>4) (During the home confinement)	49	0.780 (0.240)
			Socio economic level (Low)	88	0.900 (0.110)
			Socio economic level (Medium)	422	0.850 (0.190)
			Socio economic level (High)	27	0.900 (0.100)
			Age 18-30	286	0.870 (0.170)
			Age31-50	187	0.870 (0.150)
			Age>50	64	0.830 (0.250)
			Presence of disease – Yes	427	0.800 (0.220)
			Presence of disease—No	110	0.880 (0.160)
Lim 2020	Adult Asian outpatients (age>21) in National University Hospital of Singapore known with CVD (cardiovascular disease) and the population who utility measured before the COVID-19 outbreak	EQ-5D-3L	Pre-pandemic visit	81	0.898 (0.200)
Meys 2020	Flemish patients with confirmed/suspected COVID-19 were recruited from Belgian social support group on Facebook	EQ-5D-5L	All Subjects	210	0.620 (0.190)
			Confirmed COVID-19	49	0.630 (0.200)
			Symptom-Based COVID-19	105	0.610 (0.170)
			Suspected COVID-19	56	0.610 (0.200)
			Representative sample of general population	NR	0.880
			Patients with respiratory diseases such as COPD (Chronic obstructive pulmonary disease)	NR	0.510

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Patients with respiratory diseases such as asthma	NR	0.770
Ungureanu 2020	Resident or young specialist working in the gastroenterology department. Recruiting from 9 public hospitals of major university centers	15D	Gastroenterology fellow group	64	0.966 (0.055)
			Young specialist group	32	0.966 (0.036)
			Designated COVID-19 hospital	25	0.957 (0.061)
			Non-designated COVID-19 hospital	71	0.966 (0.041)
Than 2020	Frontline HCWs working at the NHTD and the Center for Tropical Diseases (CTD) of Bach Mai Hospital (BMH)	EQ-5D-5L	Total	173	0.930
			COVID-19 Designated Hospital	106	0.870
			COVID-19 Non-Designated Hospital	67	0.930
GUO 2020	Chinese patients with skin diseases during COVID-19 pandemic	EQ-5D-3L	Isolation status—Unaffected	506	0.960
			Isolation status—Restricted	506	0.930
			Isolation status—Isolated	506	0.930
			Income change—Unaffected	506	0.960
			Income change—Reduce	506	0.940
			Income change—Completely lost	506	0.920
			Unemployment status—Unaffected	506	0.950
			Unemployment status—Unemployed	506	0.910
			Adherence to treatment—Adherent	506	0.930
			Adherence to treatment—No treatment needed	506	0.970

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Adherence to treatment—Nonadherent	506	0.930
Ferreira 2020	Non representative sample of Portugal adult population	EQ-5D-5L	Under COVID-19 quarantine	904	0.861 (0.027)
			Pre-COVID-19 pandemic	904	0.887 (0.005)
Hay 2020	Non representative samples of Amazon Mturk workers in USA	EQ-5D-5L	Ages 18–24 (During the pandemic)	2749	0.752 (0.281)
			Ages 18–24 (Pre pandamic)	40	0.921 (0.124)
			Ages 18–24 (Online norms)	2108	0.844 (0.184)
			Ages 18–24 (Face to face US population norms)	1134	0.919 (0.120)
			Ages 25–34 (During the pandemic)	2746	0.825 (0.235)
			Ages 25–34 (Pre-pandemic)	40	0.860
			Ages 25–34 (online norms)	2018	0.811
			Ages 25–34 (Face to face population norms)	1134	0.911 (0.111)
			Ages 35-44 (During the pandemic)	2746	0.845
			Ages 35-44 (Pre pandemic)	40	0.867
			Ages 35-44 (Online norms)	2018	0.794
			Ages 35-44 (Face to face norms)	1134	0.841
			Ages 45-54 (During the pandemic)	2746	0.818
			Age 45-54 (Pre-pandemic)	40	0.736

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Ages45-54 (Online norms)	2018	0.760
			Ages 45-54 (Face to face norms)	1134	0.816
			Ages55–64 (During the pandemic	2746	0.817
			Age55-64 (Pre-pandemic)	40	0.766
			Age55-64 (Online norms)	2018	0.781
			Age55-64(Face to face norms)	1134	0.815
			Age≥65 (During the pandemic)	2746	0.827 (0.213)
			Age≥65 (Pre-pandemic)	40	0.831
			Age≥65 (Online norms)	2018	0.831
			Age (≥65) （Face to face norms）	1134	0.819
Alinia 2020	COVID-19 patients who were discharged from three hospitals over the past (research period)2 weeks in Iran	EuroQoL VAS	Overall (Among different socio-economic subgroups)	287	0.863
			Traders (Among different socio-economic subgroups)	191	0.793
			Non-traders (Among different socio-economic subgroups)	96	1
			Age groups-Young (< 40 years)	109	0.917
			Age groups-Middle age (40–65 years)	115	0.877
			Age groups—Elderly (> 65 years)	63	0.742
			Gender—Male	143	0.851

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Gender—Female	144	0.874
			Marital Status—Single	67	0.889
			Marital Status—Married	218	0.853
			Place of residence—Urban	250	0.871
			Place of residence—Rural	37	0.804
			Education—Illiterate	70	0.821
			Education—Non university	136	0.862
			Education—University	70	0.893
			Employed—Yes	125	0.882
			Employed—No	156	0.846
			Having basic insurance—Yes	264	0.863
			Having basic insurance—No	22	0.851
			Household dimension--< 3 persons	119	0.834
			Household dimension→ 3 persons	168	0.882
			Standardized household's monthly c—-- Lowest (< 50 USD)	193	0.870
			Standardized household's monthly c—t--Highest (> 50 USD)	94	0.846
			[Based on clinical characteristic— --Total	287	0.863
			Having underlying dise—e--Yes	107	0.818

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Having underlying disease—No	180	0.889
			Patient's condit—n--Quarantine at home	123	0.896
			Patient's condit—n--General wards hospitalized	147	0.847
			Patient's condit—n--ICU hospitalized-non-intubated	13	0.766
			Patient's condit—n--ICU hospitalized-intubated	4	0.629
			Hospitalized d—s--1 day	77	0.872
			Hospitalized d—s--1–4 days	115	0.875
			Hospitalized d—s--Over 4 days	95	0.840
			Blood oxygen saturat—n--Normal (Over 95%)	70	0.881
			Blood oxygen saturat—n--Below normal (Under 95%)	217	0.857
			Degree of lung involvem—t--Non/minor involved	64	0.927
			Degree of lung involvem—t--Poorly involved	190	0.844
			Degree of lung involvem—t--Moderately involved	28	0.859

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Degree of lung involvem—t--Severely involved	5	0.651
			Perceived total health status--> 0.7	206	0.869
			Perceived total health sta—s--0.5–0.7	23	0.894
			Perceived total health status--<0.5	582	0.826
van Rüth 2020	Homeless persons of Hamburg in specialized medical practices or lodging houses shelters for the night	EQ-5D-5L	General population (2014)	NR	0.880 (0.180)
			Age—5--54 years (Average EQ-5D in 2014)	NR	0.870 (0.170)
			Age—5--54 years (Men: EQ-5D in 2014)	NR	0.890 (0.150)
			Age—5--54 years (Women: EQ-5D in 2014)	NR	0.860 (0.190)
			Homeless people	111	0.840 (0.230)
Gamberini 2020	Adult patients from 16 Italian ICUs and infected COVID-19 due to respiratory failure and need of invasive mechanical ventilation during ICU stay	15D	Italian general population	NR	0.928 (0.809)
			Finnish general population	NR	0.914 (0.084)
			Study population	205	0.85 (0.143)
Turcu-Stiolica 2021	Pharmacists working in community pharmacies who were with possible contacted with COVID-19 patients from Romania and Bulgaria	15D	Romania	241	0.956 (0.051)
			Bulgarian	154	0.936 (0.063)
Clement 2020	Ten orthopaedic departments in the UK of patients on the NHS waiting lists for either a total hip (THA) or total (TKA) or partial knee arthroplasty (PKA) during the months of August and September 2020	EQ-5D-5L	THA (Control) According to group	2073	0.360 (0.325)
			THA (2020) According to group	394	0.241 (0.351)
			KA (Control) According to group	2168	0.408 (0.311)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			KA (2020) According to group	449	0.335 (0.327)
			THA (Proceed) According to whether the patient wanted to proceed or defer their total hip or knee arthroplasty	351	0.224 (0.345)
			THA (Defer) According to whether the patient wanted to proceed or defer their total hip or knee arthroplasty	43	0.385 (0.362)
			KA (Proceed) According to whether the patient wanted to proceed or defer their total hip or knee arthroplasty	375	0.328 (0.322)
			KA (Defer) According to whether the patient wanted to proceed or defer their total hip or knee arthroplasty	74	0.37 (0.351)
			THA According to whether they were waiting for a total hip or knee arthroplasty	394	0.241 (0.351)
			KA According to whether they were waiting for a total hip or knee arthroplasty	449	0.335 (0.327)
Bäuerle 2020	non representative sample of German adult population	EQ-5D-3L	Before COVID-19 outbreak	15037	0.823

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			After COVID-19 outbreak	15037	0.802
Szabó 2020	Non representative sample inside the three public online groups of Hungary adult population	EuroQoL VAS	Overall (before eliminated the significant outliers)	431	0.731
			Overall (After eliminated the significant outliers)	418	0.751
			Hungarian healthy adults of the ESDaP Project 1 in 2013	NR	0.801
			Hungarian healthy adults of the ESDaP Project 2 in 2019	NR	0.798
			Hungarian adult participants of a National Health Survey in 2000	NR	0.704
Musche 2020	Adult cancer patients of the University Hospital Essen	EQ-5D-3L	Health status (Cancer patients)	150	0.660 (0.192)
			Health status (Healthy controls)	150	0.789 (0.187)
Beisani 2020	Patients in the bariatric surgery waiting list of an institution before Lockdown.	EQ-5D-5L	Self-rated health index (Before LD)	51	0.690 (0.018)
			Self-rated health index (After LD)	51	0.640 (0.018)
Walle-Hansen 2020	COVID-19 patients age above 60 years that were still alive 180 days after hospital admission	EQ-5D-5L	Overall (Before admission)	106	0.770 (0.167)
			Overall (After six months)	106	0.658 (0.191)
Greenhawt 2020	Non representative sample of USA adult population	EQ-5D-3L	Surveyed population	4855	0.714
			Normative population total score	NR	0.800
Navarro 2020	Patients who were COVID-19 infection from a single hospital in Mexico	EQ-5D-5L	Pre-COVID-19	115	0.950
			After-COVID-19	115	0.850

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			With alterations in the spirometry (Post COVID-19)	115	0.800
			With alterations in the spirometry (Pre-COVID-19)	115	0.950
			Without alterations in the spirometry (Post-COVID-19)	115	0.850
			Without alterations in the spirometry (Post-COVID-19)	115	0.950
			With spirometric alterations (Post-COVID-19)	20	0.800
			Without spirometric alterations (post-COVID-19)	95	0.850
Machado 2020	Participates who recovered form COVID-19 infection that also from two Facebook groups that were registered at a website of the Lung Foundation Netherlands	EQ-5D-5L	Grade 0 (No functional limitations)	58	0.840
			Grade 1 (Negligible functional limitations)	157	0.800
			Grade 2 (Slight functional limitations)	643	0.750
			Grade 3 (Moderate functional limitations) and	1011	0.600
			Grade 4 (Severe functional limitations)	70	0.380
Todt 2020	Adult patients infected by COVID-19 and survived to hospital discharge	EQ-5D-3L	Overall: 3 months following discharge	251	0.801
			Before the onset of COVID-19 symptoms	251	1
Iqbal 2020	Adult patients from Laboratory and recovered from COVID-19	EQ-5D-5L	Overall	158	0.707 (0.224)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
Giusiano 2021	ALS patients were at the Turin ALS Center	EQ-5D-5L	Total (patien—)--Patients T1 (One month after the beginning of the Italian national lockdown)	60	0.500
			Total (Patients) Patients—2--one month after the end of the national lockdown	60	0.600
			Caregivers T1 (One month after the beginning of the Italian national lockdo”n)"	59	0.290
			Caregivers T2 (One month after the end of the national lockdown)	59	0.310
Douglas 2021	HCWs in a university neurosciences center	EQ-5D-5L	Total	231	0.821 (0.159)
			Doctors	231	0.834 (0.112)
			Nurses	231	0.805 (0.184)
			Allied health professional (AHPs)	231	0.863 (0.125)
Zhou	Women at each gestational age between 24 and 32weeks who were hospitalized with PPROM and found to be COVID-19 positive.	EQ-5D-5L	Maternal ICU admission	NR	0.66
			Neonatal ICU admission, maternal perspective	NR	0.95
			Infant neurodevelopmental delay （Maternal perspective）	NR	0.76
			Infant neurodevelopmental delay （Infant perspective）	NR	0.69
Xu.	Non representative Chinese adult	EQ-5D-5L	Overall	NR	0.91 (0.14)

Study	Study population	Utility measurement	Health state	N for group utility measured	Utility mean (SD)
			Alone	NR	0.89 (0.18)
			Only children	NR	0.89 (0.13)
			Only parents/ grandparents	NR	0.91 (0.15)
			Only partner	NR	0.92 (0.12)
			Partner and children	NR	0.92 (0.12)
			Partner, children and parents	NR	0.93 (0.14)
Wong, E.	Employees in workplace in Hong Kong, China	EQ-5D-5L	Overall	1048	0.897 (0.126)
			Managers and Administrator	122	0.895 (0.122)
			Professionals	82	0.89 (0.122)
			Associate Professionals	261	0.884 (0.919)
			Service/Shop Sales Workers	134	0.919 (0.093)
			Blue-Collar Workers	493	0.898 (0.132)
Şahan, S	Patients with a history of COVID-19 diagnosis and persistent OD were recruited from a tertiary medical center and a social media support forum for chemosensory dysfunction.	EQ-5D-5L	Overall	286	0.809
Russo, G	non representative participants from Madrid	EQ-5D-5L	Overall	125	0.799 (0.205)
Ohsfeldt, R	The participants were over 65 years of age and lived in Kakeya, Matsukasa, Tane, or Tai	EQ-5D-5L	Using Self-Management 2021	84	0.7 (0.21)
			Using Self-Management 2022	84	0.78 (0.16)
			Not Using Self-Management 2021	119	0.64 (0.24)
			Not Using Self-Management 2022	119	0.64 (0.24)

Study Quality Assessment for Selected HRQoL Studies

Appendix Table 3 Study quality assessment using AXIS tool for selected HRQoL studies

Author/ Criteria	Stephen J. Halpin et al.	Eve Garrigues et al.	Weiwei Ping et al.	Beatriz Lara, B et al.	Zijun Xu et al.	Eliza Lai-Yi Wong et al.	Mena Said MD et al.	Cristina Sacrista´n-Galiste et al.o	Alexander Bäuerle et al.	Mai Quynh Vu et al.	Morteza Arab-Zozani et al.	Asma a Azizi et al.	Csanád Szabó et al.	Venja Musche et al.	Roy Meys et al.	Marc Beisani et al.
Introduction																
1. Clear aims/objectives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Methods																
2. Appropriate study design	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Sample size justified	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No
4. Target population clearly defined	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Sample frame appropriate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Representative selection process	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Measures for non-responders	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
8. Appropriate risk factor and outcome variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

9. Correct measurement using validated instruments	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10. Clear statistical significance/precision estimates	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11. Sufficiently described methods	Partially	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Results																
12. Adequately described basic data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Concerns about non-response bias	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14. Information about non-responders	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
15. Internally consistent results	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16. Results for analyses described in methods presented	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Discussion																
17. Justified discussions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

and conclusions																
18. Limitations discussed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other																
19. Funding sources/conflicts of interest	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	Yes (conflict of interest noted)	‘utcome’cts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	Yes	No conflicts of interest declared
20. Ethical approval or consent attained	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table 3 Study quality of selected HRQoL studies (Continues)

	Bogdan Silviu Ungureanu et al.	**Hung Manh Than et al.**	**Yeye Guo et al.**	**Lara N. Ferreira et al.**	**Joel W. Hay et al.**	**Cyrus Alinia et al.**	**M. M. Walle-Hansen et al.**	**Matthew Greenhawt et al.**	**V. van Rüth et al.**	**Felipe V. C. Machado et al.**	**Ayman Iqbal et al.**	**Adina Turcu-Stiolica et al.**	**Silvia Giusiano et al.**	**N. D. Clement et al.**	**Deborah R. Douglas et al.**
Introduction															
1. Clear aims/objectives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Methods															
2. Appropriate study design	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Sample size justified	No	No	No	No	Yes	No	No	No	No	No	Yes	Yes	No	Yes	Yes
4. Target population clearly defined	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

5. Sample frame appropriate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Representative selection process	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Measures for non-responders	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
8. Appropriate risk factor and outcome variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9. Correct measurement using validated instruments	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10. Clear statistical significance/precision estimates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11. Sufficiently described methods	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Results															
12. Adequately described basic data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Concerns about non-response bias	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14. Information about non-responders	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
15. Internally consistent results	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16. Results for analyses described in	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

methods presented															
Discussion															
17. Justified discussions and conclusions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18. Limitations discussed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other															
19. Funding sources/conflicts of interest	Yes	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared	No conflicts of interest declared
20. Ethical approval or consent attained	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table 4 Study quality assessment using NOS tool for selected HRQoL studies

Ryuichi Ohta et al.			M. M. W Hansen et al.			Beatriz Costa Todt et al.			Shir Lynn Lim et al.			Lorenzo Gamberini et al.		
Criteria Selection	Assessment	S	Criteria Selection	Assessment	S	Criteria Selection	Assessment	S	Criteria Selection	Assessment	S	Criteria Selection	Assessment	Stars
1. Representativeness of the exposed cohort	Selected group of rural older people over 65 years old, high aging rate but specific demographic focus.	★	1. Representativeness of the exposed cohort	Patients aged 60 and older hospitalized due to COVID-19, covers a broad age range.	★	1. Representativeness of the exposed cohort	Likely includes survivors of COVID-19, representative of this group.	★	1. Representativeness of the exposed cohort	Patients with CVD from a large tertiary hospital, representing a multi-ethnic Asian population.	★	1. Representativeness of the exposed cohort	Critically ill COVID-19 patients from multiple Italian ICUs, representative of the severely affected population.	★
2. Selection of the non-exposed cohort	Drawn from the same community as the exposed cohort.	★	2. Selection of the non-exposed cohort	No separate non-exposed cohort, all participants had COVID-19.		2. Selection of the non-exposed cohort	No separate non-exposed cohort, all participants are COVID-19		2. Selection of the non-exposed cohort	Not applicable, as there is no non-exposed cohort.		2. Selection of the non-exposed cohort	Age and sex-matched Italian and Finnish general populations as	★

						survivors.						reference groups.		
3. Ascertainment of exposure	Self-reported questionnaire on self-management preferences.	★	3. Ascertainment of exposure	Hospital records confirming COVID-19 diagnosis.	★	3. Ascertainment of exposure	Confirmed COVID-19 diagnosis via medical records.	★	3. Ascertainment of exposure	HRQoL assessed using EQ-5D questionnaire.	★	3. Ascertainment of exposure	COVID-19 diagnosis and ICU admission confirmed by medical records.	★
4. Demonstration that outcome of interest was not present at start of study	Excluded participants who preferred self-management at baseline.	★	4. Demonstration that outcome of interest was not present at start of study	Assessed pre-COVID-19 health retrospectively at follow-up.	★	4. Demonstration that outcome of interest was not present at start of study	Outcomes (clinical and QOL measures) were assessed post-COVID-19.	★	4. Demonstration that outcome of interest was not present at start of study	Baseline HRQoL assessment prior to the pandemic.	★	4. Demonstration that outcome of interest was not present at start of study	Assessed HRQoL post-ICU discharge, ensuring baseline was pre-discharge.	★
Comparability			Comparability			Comparability			Comparability			Comparability		
1. Comparability of cohorts on the basis of the	Adjusted for key covariates such as age, sex, socioec	★★	1. Comparability of cohorts on the basis of the	Adjusted for age and disease severity.	★★	1. Comparability of cohorts on the basis of the	Likely adjusted for age and baseline health status.	★★	1. Comparability of cohorts on the basis of the	Adjusted for sociodemographic and clinical factors.	★★	1. Comparability of cohorts on the basis of the	Adjusted for age, sex, comorbidities, ARDS class,	★★

design or analysis	onomic status.		design or analysis			design or analysis			design or analysis			design or analysis	and duration of mechanical ventilation.	
Outcome			Outcome			Outcome			Outcome			Outcome		
1. Assessment of outcome	Outcomes assessed using EQ-5D-5L. Adequate follow-up duration (2021-2022), high loss to follow-up	★	1. Assessment of outcome	Used EQ-5D-5L to measure HRQoL and functional status.	★	1. Assessment of outcome	Used validated tools for QOL and clinical outcomes assessment.	★	1. Assessment of outcome	Used EQ-5D instrument for HRQoL assessment.	★	1. Assessment of outcome	Used 15D instrument for HRQoL assessment.	★
2. Was follow-up long enough for outcomes to occur	One year follow-up period.	★	2. Was follow-up long enough for outcomes to occur	Six-month follow-up period.	★	2. Was follow-up long enough for outcomes to occur	Follow-up period appropriate for observing long-term effects.	★	2. Was follow-up long enough for outcomes to occur	Follow-up during the pandemic.	★	2. Was follow-up long enough for outcomes to occur	90-day follow-up period post-ICU discharge.	★

3. Adequacy of follow-up of cohorts	High follow-up rate with clear documentation of missing data.	★	3. Adequacy of follow-up of cohorts	High follow-up rate with clear documentation of those lost to follow-up.	★	3. Adequacy of follow-up of cohorts	Likely documented follow-up procedures and rates.	★	3. Adequacy of follow-up of cohorts	High follow-up rate, with detailed documentation of assessments.	★	3. Adequacy of follow-up of cohorts	Adequate follow-up with detailed documentation of respondent and non-respondent characteristics.	★
Total Stars		8	Total Stars		7	Total Stars		7	Total Stars		8	Total Stars		9

Appendix Table 5 Study quality assessment using CHEERS tool for selected HRQoL studies

Clarice G. Zhou et al.	
1. Title	Yes. The title clearly identifies the study as a decision analysis regarding antenatal corticosteroids.
2. Abstract	Yes. The abstract is structured and includes the objectives, methods, results, and conclusions.
Introduction	
3. Background and Objectives	Yes. The introduction provides context about the use of corticosteroids and the need to evaluate their use in the context of COVID-19.
Methods	
4. Target Population and Subgroups	Yes. The study describes a theoretical cohort of 10,000 women at each gestational age between 24 and 32 weeks with COVID-19 and PPROM.
5. Setting and Location	No. The setting and specific geographic location are not explicitly mentioned, but it is implied that the context is clinical settings where women with PPROM and COVID-19 are treated.
6. Study Perspective	Yes. The study uses a healthcare perspective, focusing on maternal and infant outcomes and QALYs.
7. Comparators	Yes. The study compares antenatal corticosteroid administration versus no corticosteroid administration.

8. Time Horizon	Yes. The time horizon is the period between 24 and 32 weeks of gestation, focusing on short-term outcomes of maternal and infant health.
9. Discount Rate	No. The study does not mention the application of discount rates, which might be less relevant due to the short time horizon.
10. Choice of Health Outcomes	Yes. The primary outcomes include QALYs, ICU admissions, maternal and infant deaths, respiratory distress syndrome, intraventricular hemorrhage, and neurodevelopmental delay.
11. Measurement of Effectiveness	Yes. Effectiveness data are derived from existing literature and clinical data on the outcomes of corticosteroid use and COVID-19 complications.
12. Measurement and Valuation of Preference-Based Outcomes	Yes. QALYs are used to measure and value health outcomes, and the methodology for these is explained.
13. Estimation of Resources and Costs	No. There is no detailed explanation of the cost estimation or resource use, focusing primarily on health outcomes.
14. Currency, Price Date, and Conversion	No. The study does not mention currency, price date, or conversions, as it focuses on theoretical outcomes rather than specific costs.
15. Analytic Methods	Yes. The study uses deterministic and probabilistic sensitivity analyses to evaluate model assumptions.
Results	
16. Study Parameters	Yes. Key parameters include ICU admissions, maternal and infant deaths, respiratory distress syndrome, intraventricular hemorrhage, neurodevelopmental delay, and QALYs.
17. Incremental Costs and Outcomes	No. The study focuses on outcomes but does not report incremental costs, which are typical in health economic evaluations.
18. Characterizing Uncertainty	Yes. Uncertainty is addressed through sensitivity analyses.
19. Characterizing Heterogeneity	No. The study does not provide a detailed discussion of heterogeneity across different subgroups beyond gestational ages.
Discussion	
20. Study Findings, Limitations, Generalizability, and Current Knowledge	Yes. The discussion interprets the findings, acknowledges limitations, and places the results in the context of existing knowledge.
Other	
21. Source of Funding	No. The source of funding is not mentioned.
22. Conflicts of Interest	No. There is no mention of conflicts of interest.
23. Ethical Approval	No. As this is a decision-analytic model study, ethical approval is not typically required, but there is no statement clarifying this.
24. Availability of Data and Materials	No. There is no mention of the availability of data and materials.

Consolidated Health Economic Evaluation Reporting Standards (CHEERS)

The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) is a set of guidelines developed to improve the reporting quality of health economic evaluations. These standards are designed to ensure that studies are transparent, comprehensive, and provide sufficient information for readers to understand the methodology, context, and applicability of the findings.

Components of CHEERS

The CHEERS checklist consists of 24 items, grouped into several categories:

Title and Abstract:

Title: Should identify the study as an economic evaluation.

Abstract: Provide a structured summary including objectives, methods, results, and conclusions.

Introduction:

Background and Objectives: Describe the study's context, rationale, and objectives.

Methods:

Target Population and Subgroups: Describe characteristics of the population and subgroups analyzed.

Setting and Location: Indicate where the data was collected and the geographic location relevant to the study.

Study Perspective: Define the perspective (e.g., societal, healthcare system).

Comparators: Clearly state the interventions or strategies compared.

Time Horizon: Describe the time span over which costs and outcomes are measured.

Discount Rate: Report the discount rate(s) applied to costs and outcomes.

Choice of Health Outcomes: Describe the primary health outcomes used (e.g., QALYs, DALYs).

Measurement of Effectiveness: Explain how the effectiveness data was obtained.

Measurement and Valuation of Preference-Based Outcomes: Describe the methods used to value health outcomes.

Estimation of Resources and Costs: Provide details on how resources and costs were measured and valued.

Currency, Price Date, and Conversion: Report the currency, price date, and any conversion rates used.

Analytic Methods: Explain the methods used for analyzing data and handling uncertainty.

Results:

Study Parameters: Summarize the key parameters used in the analysis.

Incremental Costs and Outcomes: Report the differences in costs and outcomes between comparators.

Characterizing Uncertainty: Describe how uncertainty in the analysis was addressed.

Characterizing Heterogeneity: Discuss variations in outcomes across different subgroups.

Discussion:

Study Findings, Limitations, Generalizability, and Current Knowledge: Interpret the results, discuss limitations, and compare findings with existing literature.

Other:

Source of Funding: Disclose the funding sources for the study.

Conflicts of Interest: Report any potential conflicts of interest.

Newcastle-Ottawa Scale (NOS)

The Newcastle-Ottawa Scale (NOS) is a widely used tool for assessing the quality of non-randomized studies, particularly cohort and case-control studies. The NOS evaluates studies based on three broad domains: Selection, Comparability, and Outcome (or Exposure for case-control studies). Each domain contains several specific criteria, and studies can be awarded a maximum of nine stars. Here is a detailed description of the NOS:

Domains and Criteria

1. Selection (Maximum of 4 stars)

This domain assesses how well the study cohorts are selected and defined.

Representativeness of the exposed cohort: Evaluates whether the exposed cohort is truly representative of the average population exposed to the risk factor.

Star: If the cohort is truly representative.

No star: If the cohort is somewhat or not representative.

Selection of the non-exposed cohort: Assesses whether the non-exposed cohort is drawn from the same population as the exposed cohort.

Star: If the non-exposed cohort is drawn from the same community.

No star: If the non-exposed cohort is from a different source.

Ascertainment of exposure: Determines how exposure is assessed.

Star: If the exposure is clearly defined and measured using secure records or structured interviews.

No star: If exposure is self-reported or not clearly defined.

Demonstration that outcome of interest was not present at start of study: Ensures that the outcome was not already present in participants at the beginning of the study.

Star: If it is demonstrated.

No star: If it is not demonstrated.

2. Comparability (Maximum of 2 stars)

This domain evaluates whether the study controls for confounding variables.

Comparability of cohorts on the basis of the design or analysis: Assesses whether the study design or analysis controlled for key confounders.

Star: For studies that control for the most important factor (e.g., age, gender).

Additional star: For studies that control for additional factors.

3. Outcome (for cohort studies) or Exposure (for case-control studies) (Maximum of 3 stars)

This domain assesses how the outcomes are measured and how follow-up is conducted.

Assessment of outcome: Evaluates how the outcomes are measured.

Star: If outcomes are assessed using independent blind assessment or secure records.

No star: If outcomes are self-reported or not clearly defined.

Was follow-up long enough for outcomes to occur: Ensures that the follow-up period is sufficient for the outcomes to occur.

Star: If the follow-up period is long enough.

No star: If the follow-up period is not long enough.

Adequacy of follow-up of cohorts: Assesses whether all participants are accounted for at the end of the study.

Star: If follow-up is complete or loss to follow-up is adequately described and is less than 20%.

No star: If there is no description of those lost to follow-up or the loss is greater than 20%.

Scoring and Interpretation

Each study is assessed on the above criteria and awarded stars accordingly. The total number of stars indicates the overall quality of the study:

High-quality: Generally**,** studies with 7 to 9 stars.

Medium-quality: Studies with 4 to 6 stars.

Low-quality: Studies with less than 4 stars.

The NOS provides a structured and transparent way to assess the methodological quality of non-randomized studies**,** helping researchers and reviewers to evaluate potential biases and the reliability of study findings.

Appraisal tool for Cross-Sectional Studies (AXIS)

The AXIS tool (Appraisal tool for Cross-Sectional Studies) is designed to assess the quality and risk of bias in cross-sectional studies. It was developed through a Delphi process involving experts from various disciplines and incorporates elements of study design quality, reporting quality, and risk of bias. The final tool includes 20 components, each addressing a specific aspect of cross-sectional study quality.

Components of the AXIS Tool:

Introduction:

Clarity of aims/objectives.

Methods:

Appropriateness of study design.

Justification of sample size.

Definition of target/reference population.

Appropriateness of sample frame.

Representativeness of selection process.

Measures to address and categorize non-responders.

Appropriateness of measured variables.

Correct measurement of variables using validated instruments.

Clarity of statistical significance and precision estimates.

Sufficient description of methods, including statistical methods.

Results:

Adequate description of basic data.

Concerns about non-response bias.

Description of non-responders.

Internal consistency of results.

Presentation of results for analyses described in methods.

Discussion:

Justification of authors

Discussion of study limitations.

Other:

Disclosure of funding sources or conflicts of interest.

Attainment of ethical approval or participant consent.

Appendix Table 6 Diagnostic parameters of logistic regression of HRQoL study

Model	Hosmer and Lemeshow Test		Omnibus Tests of Model Coefficients			Model Summary			Model Coefficients					Overall Percentage	
	Chi-square	df	Sig.	Chi-square	df	Sig.	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square	B	S.E.	Wald	df	Sig.	Exp(B)	%
Mobility	8.533	8	0.383	400.95	28	0	2142.169[a]	0.182	0.252	-0.698	0.047	216.125	1	0.000	0.498	72.7
Self-supply	23.862	8	0.002	191.31	28	0	1174.387	0.091	0.184	-2.116	0.072	859.489	1	0.000	0.121	89.5
Usual activities	11.721	8	0.164	288.71	28	0	1968.407[a]	0.134	0.199	-1.089	0.052	446.942	1	0.000	0.337	77.6
Pain/ Discomfort	24.896	8	0.002	193.03	28	0	2574.173[a]	0.092	0.123	-0.104	0.045	5.376	1	0.020	0.901	63.8
Anxiety/ Depression	18.445	8	0.018	166.51	28	0	2363.696[a]	0.080	0.111	-0.719	0.048	227.488	1	0.000	0.487	68.7

Note: Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001.

Appendix Table 7 Diagnostic parameters of linear regression of HRQoL and life satisfaction study

HRQoL Model				
Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate

1		0.306[a]	0.094	0.089	0.21608		
ANOVA							
Model			Sum of Squares	Df	Mean Square	F	Sig.
1		Regression	9.622	11	0.875	18.735	.000
		Residual	92.824	1988	0.047		
		Total	102.446	1999			
Life satisfaction study models							
SWLS Model							
Model Summary							
Model		R	R Square	Adjusted R Square	Std. Error of the Estimate		
	1	.239[a]	0.057	0.051	7.47083		
ANOVA							
Model			Sum of Squares	Df	Mean Square	F	Sig.
	1	Regression	6718.970	12	559.914	10.032	.000
		Residual	110901.130	1987	55.813		
		Total	117620.100	1999			
Anxiety Model							
Model		R	R Square	Adjusted R Square	Std. Error of the Estimate		
	1	.325[a]	0.105	0.100	4.98187		
ANOVA							
Model			Sum of Squares	Df	Mean Square	F	Sig.
	1	Regression	5809.980	12	484.165	19.508	.000
		Residual	49315.395	1987	24.819		
		Total	55125.375	1999			
Depression Model							
Model		R	R Square	Adjusted R Square	Std. Error of the Estimate		

	1	.288[a]	0.083	0.077	5.83137		

ANOVA

Model			Sum of Squares	Df	Mean Square	F	Sig.
	1	Regression	6107.933	12	508.994	14.968	.000
		Residual	67567.590	1987	34.005		
		Total	73675.523	1999			

Appendix Table 8 Marginal effects of demographic and EQ-5D-5L dimensions

Variable	**Mobility**	**Self-care**	**Daily activities**	**Pain/ discomfort**	**Anxiety/ depression**
	No problems (Level 1) vs. Any problems (Levels 2-5)	**No problems (Level 1) vs. Any problems (Levels 2-5)**	**No problems (Level 1) vs. Any problems (Levels 2-5)**	**No problems (Level 1) vs. Any problems (Levels 2-5)**	**No problems (Level 1) vs. Any problems (Levels 2-5)**
	ME	**ME**	**ME**	**ME**	**ME**
Age (years)					
25-34	0.055	0.051	0.048	**0.115**	-0.016
35-44	0.055	**0.069**	0.017	**0.088**	-0.028
45-54	**0.184**	**0.081**	0.072	**0.157**	-0.068
55-64	**0.243**	0.059	**0.114**	**0.178**	**-0.113**
65 +	**0.300**	0.043	0.106	**0.200**	**-0.161**
Gender					
Female	0.019	-0.011	0.008	**0.057**	**0.076**
Education					
Intermediate level	-0.032	-0.009	-0.037	**-0.059**	-0.005
Higher education	**-0.088**	-0.029	**-0.077**	**-0.140**	0.006
Employment					
Employed part time	0.071	0.039	0.073	0.053	0.057
Entrepreneur	-0.036	0.039	-0.048	-0.003	-0.011
Unemployed	0.084	0.029	0.064	0.080	**0.106**
Student	-0.126	0.025	0.107	0.128	0.041

Takes care of family members	0.024	-0.003	0.027	0.031	0.023
Retired	**0.120**	**0.110**	**0.125**	**0.102**	0.021
Disabled pensioner	**0.568**	**0.428**	**0.639**	**0.442**	**0.368**
Inactively seeking employment	**0.235**	**0.161**	0.150	**0.202**	**0.346**
Other occupational status	0.112	0.085	0.119	0.119	0.064
Monthly income (Euro)					
900 – 2571	-0.025	**-0.034**	**-0.048**	-0.021	**-0.056**
2572 +	-0.029	/	**-0.198**	-0.183	**-0.227**
I don't know / I don't answer	**-0.084**	-0.021	**-0.077**	**-0.071**	**-0.086**
Have you been infected with COVID-19?					
No	0.090	-0.015	0.022	0.001	0.106
Has anyone in your household been infected with COVID-19					
No	-0.040	0.003	0.016	-0.019	**-0.019**
Has a close family member not in the household had a COVID-19 infection?					
No	-0.002	0.003	-0.010	-0.034	-0.040
Severity of COVID-19 infection					
Mild symptoms that did not affect daily activities	0.053	-0.010	0.010	-0.040	0.068
Perceived severe symptoms that limited daily activities (e.g., needed bed rest)	0.131	0.002	0.068	0.109	0.108
Needed hospital care or intensive care unit care	0.354	0.108	0.288	0.256	0.278
Have you been quarantined?					
No	0.013	0.018	0.011	-0.011	0.007
Have you been vaccinated against COVID-19?					
No	-0.011	0.006	-0.007	0.020	-0.021