A Health Economic Model on Urban Green Space Quality and Application to Design Proposals in Skåne, Sweden

Moa Morency, Sanjib Saha, Ulf-G Gerdtham & Johan Jarl[1]

Health Economics

Department of Clinical Sciences, Malmö

Lund University, 2026-03-10

Contact: Johan.Jarl@med.lu.se

Karl Magnus Adielsson

Regional Development

Region Skåne, 2026-03-10

Contact: KarlMagnus.Adielsson@skane.se

[1] The unpublished reviews by Aljona Nesterovich and Cristian Pisani on health economic and epidemiological research on urban green spaces has been used in the current report and is greatly acknowledged. We also gratefully acknowledge the work by Lova Eriksson, Amanda Hansson and Sigrid Larsson for their PSD-assessments of the examples included in the current report, which was done within their participation in the course MVEN24 at Lund University.

Contents

Abbreviations:

UGS: Urban Green Space

GSQ: Green Space Quality

PSDs: Perceived Sensory Dimensions

SGS: Scania Green Score

GIS: Geographical Information System

TP: Transition Probability

PMH: Poor Mental Health

GHQ12: General Health Questioner 12

PALP: Physical Activity Level Proportion

QALYs: Quality Adjusted Life Years

1. Introduction

A growing body of evidence highlights the substantial health benefits associated with access to urban green spaces (UGS). The World Health Organization's 2016 evidence review, together with a major meta-analysis, demonstrates strong and consistent associations between exposure to green spaces and reduced all-cause mortality, lower incidence of cardiovascular disease, and improved mental health (Twohig-Bennett & Jones, 2018; WHO, 2016). Consequently, UGS are increasingly recognized as important instruments for promoting public health in both the short and long term. Three primary mechanisms have been proposed (Zhang et al., 2017). First, physical health benefits arise through exposure to phytoncides and negative air ions emitted by vegetation, mitigation of air pollution and urban heat islands, and enhanced resilience to climate change impacts. Second, contact with natural environments has been shown to reduce stress and improve vitality and attention restoration, factors linked to both mental and physical health. Third, UGS can encourage positive health behaviours, notably physical activity and social interaction, which are associated with broad health outcomes. Each mechanism may also entail potential adverse effects, such as allergies, zoonotic diseases, discomfort or fear, and opportunities for criminal activity (Zhang et al., 2017).

Despite these well-documented health effects, the benefits of UGS are often undervalued or overlooked in urban planning (Bratman et al., 2019). A likely explanation is the challenge of balancing green space provision against other societal priorities without explicit quantification of its health benefits, which frequently results in suboptimal urban design. As evidence of UGS benefits strengthens and the complexity of integrating these benefits into planning decisions grows, there is increasing demand from planners and stakeholders for tools that enable systematic consideration of UGS in decision-making (Bratman et al., 2019). Moreover, recent findings indicate that health impacts depend not only on access to UGS but also on how individuals perceive and experience their characteristics and qualities (Grahn & Stigsdotter, 2010).

This report outlines the initial development of a tool for estimating the health economic impacts of UGS, intended for use by local and regional decisionmakers. Specifically, we aim to construct a health economic model informed by the latest evidence on UGS health effects, incorporating measures of green space quality.

Part 2 of this report provides background on UGS qualities and health economic evaluation. Part 3 outlines the methodology, presenting the conceptual model and detailing its structure and parameters. Part 4 reports preliminary results on the effects of improving UGS quality based on the model. Finally, Part 5 briefly discusses these findings in relation to model characteristics and potential applications for stakeholders and concludes with plans for further development to enhance accuracy and usability.

2. Theoretical background

In this section, we outline the theoretical background of the project, both in terms of health economic evaluation and modelling and in terms of quality of urban green spaces.

2.1 Health Economics and Its Role in Decision-Making

Health economics applies economic theory and analytical models to examine decision-making related to health and healthcare at the individual, organisational, and societal levels. Its primary objective is to provide decision-makers with evidence on the costs and consequences of different interventions, enabling efficient resource allocation and policy design that reflect societal needs in a comprehensive and systematic manner.

The foundation of health economic evaluation is the principle that society's limited resources should be used as efficiently as possible to maximize population health and well-being. A central tool for achieving this is cost-effectiveness analysis, which compares the value of an intervention relative to its costs against one or more alternatives. Cost-effectiveness is therefore a relative concept, guiding prioritization among interventions or population groups within existing resource constraints. While originally developed for healthcare, similar approaches are applied in other public sectors where collective decisions are made, such as traffic safety and environmental or climate policy.

Over the past decades, health economic evaluations have become a cornerstone of transparent and evidence-based priority setting in healthcare. Their purpose is to provide decision support that enables choices maximizing health and well-being under resource limitations, thereby ensuring optimal use of shared societal resources.

In economic terms, a cost is defined as the value of the best alternative use of a resource, the opportunity cost. Opportunity cost represents what must be forgone when a resource is allocated in a particular way. In health economic evaluations, costs are commonly categorized into three types (Drummond et al., 2015):

- **Direct costs**, associated with actual resource utilisation;
- **Indirect costs**, reflecting resources not produced due to illness or death, often referred to as productivity losses;
- **Intangible costs**, capturing non-material burdens such as pain, anxiety, and suffering that individuals are willing to pay to avoid.

The benefit or effect of an intervention represents the value it generates, i.e., the positive outcome of the intervention. Benefits vary across interventions but typically include reduced morbidity, decreased mortality, and improved quality of life, which often also translate into increased productivity and reduced costs for social services and healthcare.

A critical aspect of health economic evaluation is determining which costs and benefits to include, which depends on the chosen perspective and scope. A societal perspective is generally recommended, as it encompasses all costs and benefits regardless of who bears them. This perspective is considered most relevant when allocating shared societal resources.

For complex interventions or those with long-term effects, current evidence on costs and benefits is often synthesized in model-based analyses (Briggs et al., 2006; Briggs et al., 2016; Diaby et al., 2014). Health economic models are powerful tools to study the effect and cost-effectiveness of interventions when (randomised) trials are unfeasible, as in the case of UGS. It is a structured analytical framework that can combine data from clinical studies, epidemiology, and economics to simulate real-world scenarios, allowing decision-makers to predict the impact of interventions on health and resource use.

An added advantage of health economic modelling is the possibility to incorporate uncertainty, long-term effects, and multiple perspectives and thereby provide a transparent and systematic approach to prioritising interventions and designing policies that improve population health. In the current project, we construct and apply a health economic model to assess how the quality of green spaces influences long-term health outcomes and healthcare costs, with the aim of providing a transparent, evidence-based foundation for future urban planning and public health policies related to green infrastructure.

2.2 Perceived Sensory Dimensions, a framework for UGS quality

In terms of quality of UGS, we apply the Perceived Sensory Dimensions (PSDs) framework (Stoltz & Grahn, 2021). The framework describes and classifies distinct qualities of natural environments based on how people perceive them. The concept originates from environmental psychology and landscape architecture and is often applied in studies of urban green spaces. PSDs capture the subjective perception of different characteristics of a setting, which influence how individuals interact with and benefit from the environment.

The PSD framework has been refined over time, and currently consists of eight qualities, ranging from “serene” to “social.” Importantly, some of these dimensions are considered restorative, while others relate more to cultural or social engagement related to overall wellbeing. Figure 1 provides an overview of the PSD framework, highlighting the most recent version of the eight qualities. Each PSD has a conceptual opposite that cannot be present at the same time in the same space, e.g., natural/cultural. However, an UGS of sufficient size can incorporate all dimensions. Figure 2 further outlines the PSD framework, including historical naming variants, Swedish translations, and which dimensions are included in the Scania Green Score (SGS). The latter is an empirical operationalisation of the PSD framework including five PSDs considered possible to approximate using geographical data (de Jong et al., 2012).

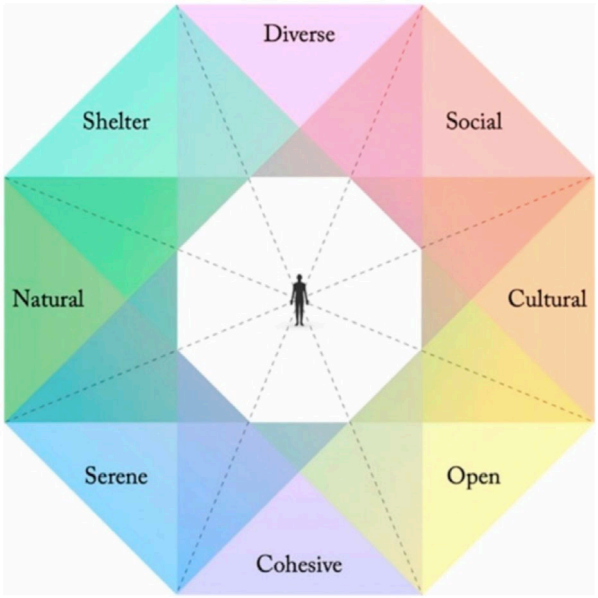

Figure 1: Map of the 8 Perceived Sensory Dimensions of an UGS

Notes: The map outlines the conceptual opposite of each PSD. Source: (Stoltz & Grahn, 2021).

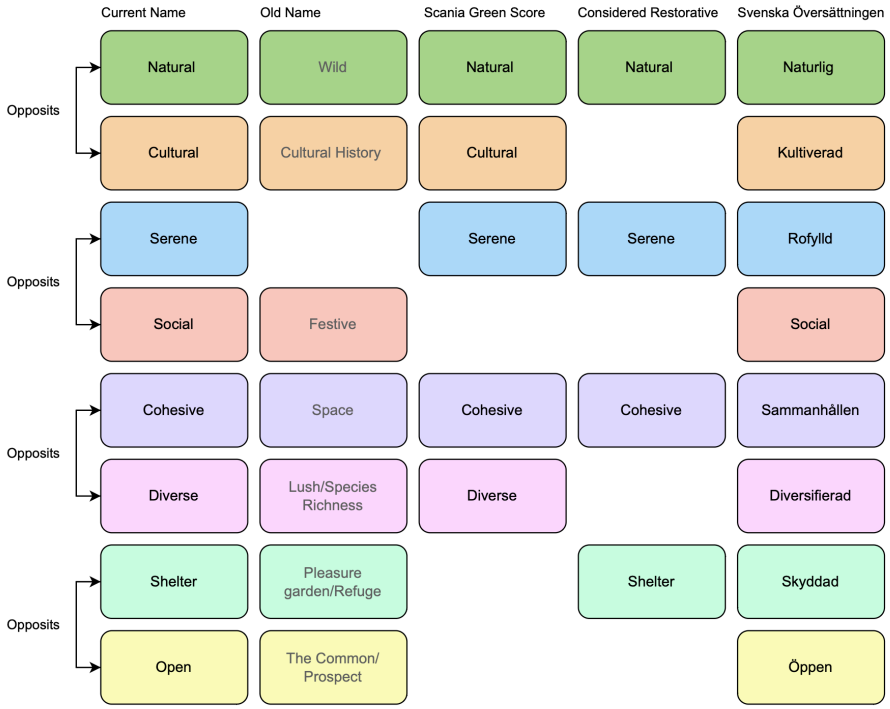

Figure 2: Perceived Sensory Dimensions name-map

Notes: This figure summarizes the PSD framework. It is colour-aligned with Figure 1. The figure includes the former names of the PSDs as well as the Swedish translations. It also includes which of the PSDs are included in the Scania Green Score (SGS) and which PSDs are considered to be "restorative".

3. Method

3.1 Overview of modelling approach

The model is a cohort-based, discrete-time Markov simulation stratified by sex and five-year age groups. The model is developed to assess the health impacts of living close to (being exposed to) better green space quality (GSQ) using the PSD conceptual framework.

A Markov model was chosen as the analytical framework due to its suitability for population-level modelling using cross-sectional data. Markov models assume that future states depend only on the current state (the "memoryless" property), which allows for simulating long-term outcomes even in the absence of individual-level longitudinal data. The simulation runs over a lifetime horizon, with one-year cycles.

The design of the integrated Markov model was guided by best practice recommendations from the International Society for Pharmacoeconomics and Outcomes Research and the Society for Medical Decision Making (ISPOR-SMDM) task force on good research practices in modelling studies (Caro et al., 2012). The same guidelines were also used to reflect on limitations throughout the model development process.

This model estimates effects on mental health and all-cause mortality. GSQ is allowed to influence these outcomes both directly (mental health) and indirectly through physical activity (mental health and mortality). Health states are assigned quality of life weights and costs (healthcare), as appropriate. Following standard practice in health economic modelling, a 3% annual discount rate is applied (Gidwani & Russell, 2020). All costs were adjusted to 2025 values (SCB, 2025). When relevant, an exchange rate of 1 € = 10.94 SEK was used.

3.2 Exposure to urban green space

It is challenging to determine population exposure to UGS, as it likely varies across a number of individual, environmental, and geographic factors. In this model, we rely on the common “near residence” approach, assuming everyone living near the UGS is exposed. This is operationalised as living within 300 meters of the UGS, equivalent to a 5-10 minute walk from home (WHO, 2016). Information on the population size and demographic characteristics within 300 meters of each UGS evaluated in the current project is supplied by Region Skåne. We apply a simplifying assumption of no variation in exposure between individuals within the zone of exposure.

3.3 Green Space Quality Quantification

The supporting effect-studies quantify perceived sensory dimensions (PSDs) using several methods, most commonly by assessing whether each PSD is present or not, following the Scania Green Score framework, see Figure 3 (Björk et al., 2008; Van den Bosch et al., 2015). A similar PSD-based assessment protocol is also used in the PSD-assessment of the UGS-examples included in the current report (Eriksson et al., 2026).

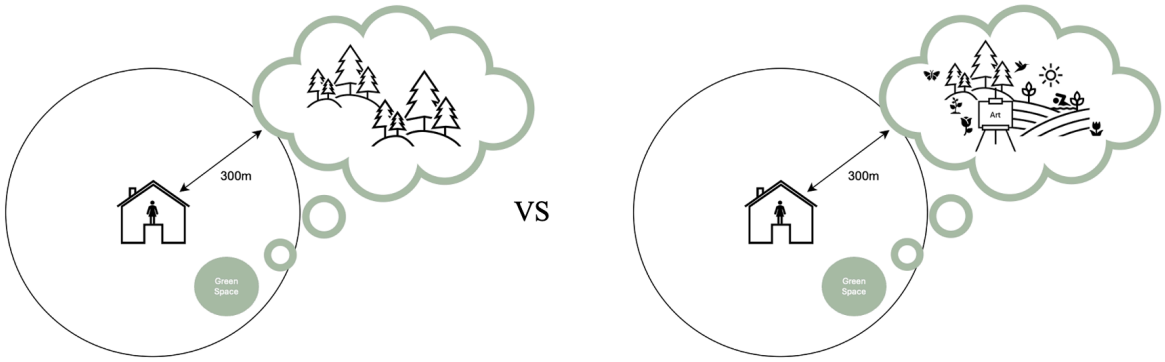

Figure 3: Exposure to UGS.

Notes: The individual on the left is exposed to one PSD, whereas the individual on the right is exposed to four PSDs. Both have access to UGS within 300 m of their residence; the difference lies in the number of PSDs present. The underlying epidemiological studies conceptually compare health outcomes between individuals with differing PSD exposure, while adjusting for potential confounders such as socioeconomic status and age, to estimate the association between PSD availability near the residence and the health outcome of interest (Björk et al., 2008; Van den Bosch et al., 2015).

3.4 Model Structure

Data were analysed and visualized using Microsoft Excel (*Microsoft Excel*, 2024). Basic structure of the spreadsheet and creation of the practical model was guided by (Briggs et al., 2006). The Markov model uses a three-state structure consisting of the states:

A: Healthy

B: Poor Mental Health, PMH

C: Death

Individuals may transition between states based on predefined transition probabilities based on sex and age in each one-year cycle. These probabilities are allowed to differ across different levels of exposure to PSD. The input variables for the calculations of the transition probabilities are derived from epidemiological data and literature. The model is presented in Figure 4.

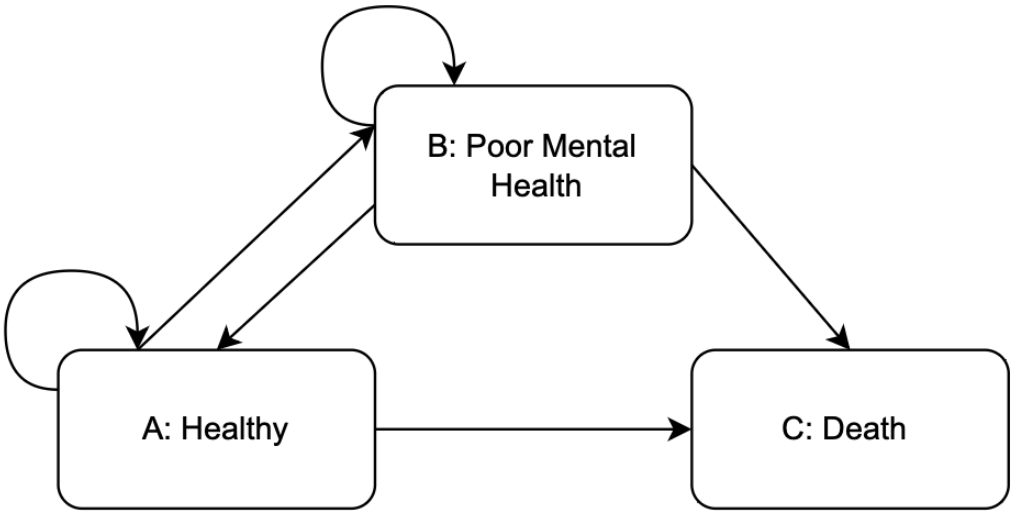

Figure 4: Markov state transition diagram

Notes: Three Markov health states where the arrows denote the state transition probabilities.

A person in the Healthy state has a certain risk of poor mental health or death in each cycle. The person in the Poor mental health state has a likelihood of recovery (move back to the Healthy state) and a risk of death. The Death state is an absorbing state, i.e., a state that cannot be left. An initial state distribution is applied in the models first cycle, based on the prevalence of PMH. The model runs over the lifetime of the cohort, up to 100 years of age, using 1-year cycle lengths; thus, all transition probabilities represent annual risks.

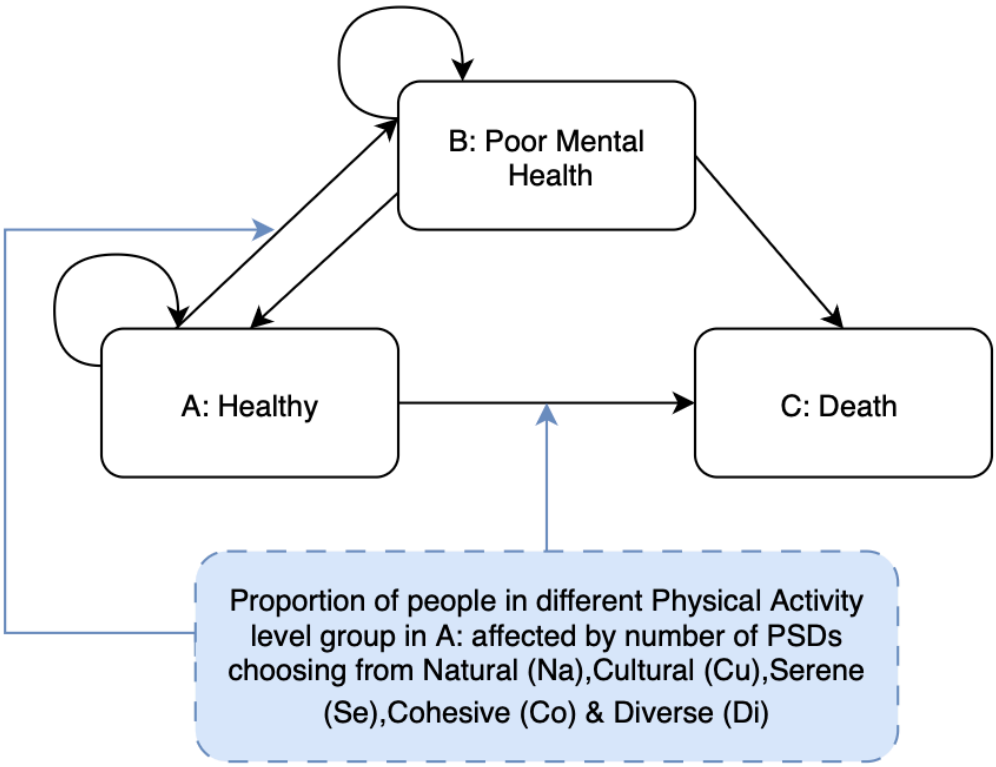

Figure 5: State transition diagram and indirect effect of GSQ on health.

Notes: Three Markov health states where arrows denote possible transitions. The blue box explains how the physical activity levels and their effect on risk of death and risk of poor mental health are included in the calculation of the transition probabilities tpa2b and tpa2c.

3.4.1 Incorporation of Physical Activity as a Risk-Factor Distribution

To account for differences in health risks associated with physical activity, the model incorporates physical activity as an external risk-factor distribution rather than as a separate set of Markov states (see Figure 5). Conceptually, the model allows green space quality to affect individuals directly, via an increased likelihood of recovery from poor mental health (Poor Mental Health → Healthy). Green space quality also has an indirect effect, through increased physical activity that affects incidence of poor mental health (Healthy → Poor Mental Health) and death from the Healthy state (Healthy → Death) (Figure 5). Practically, this is done by stratifying the population in terms of physical activity in the healthy state and assigning different transition probabilities.

Baseline population proportions in three physical activity categories (low, medium, high) were derived from observational data (Folkhälsomyndigheten, 2015). These proportions are adjusted using Björk et al. (2008) that describe how exposure to PSDs near the residence shifts the cumulative odds of belonging to a higher physical activity category.

Because the ordinal regression assumes proportional odds, the estimated odds ratios apply uniformly across all thresholds separating PA levels. The adjusted odds are converted to category-specific probabilities through renormalization, producing a new PA distribution for each exposure scenario (see below).

The resulting physical activity distributions are then used as modifiers of transition probabilities in the Markov cohort model. Specifically, mortality and disease incidence rates are weighted according to the share of the population in each physical activity category and their associated hazard ratios taken from (Lear et al., 2017). However, the definitions for the different levels of physical activity levels are different in (Lear et al., 2017) compared to (Folkhälsomyndigheten, 2015). This difference is indicated in Table 1 where **bold** indicate definitions used in (Folkhälsomyndigheten, 2015) and italic refers to the definition used by (Lear et al., 2017).

Table 1: Physical Activity Level Proportions (PALP) women from (Folkhälsomyndigheten, 2015)

Age groups	**PALP high** (**> 60min/day**; *>107 min/day*)	**PALP mid (>30min/day**; *>21 min /day*)	**PALP low** (**< 30min/day;** *< 21 min /week*)
20-24	0,369	0,31	0,321
25-29	0,369	0,31	0,321
30-34	0,348	0,318	0,334
35-39	0,348	0,318	0,334
40-44	0,348	0,318	0,334
45-49	0,319	0,296	0,385
50-54	0,319	0,296	0,385
55-59	0,319	0,296	0,385
60-64	0,319	0,296	0,385
65-69	0,301	0,275	0,424
70-74	0,301	0,275	0,424
75-79	0,301	0,275	0,424

Notes: The table shows the physical activity proportions used as input in the model from (Folkhälsomyndigheten, 2015). In terms of physical activity, definitions used by (Folkhälsomyndigheten, 2015) are shown in **bold,** while definitions from (Lear et al., 2017) for the hazard ratios are shown in *italic*.

3.5 Transition Probabilities

The model has four main transition probabilities characterizing the move between health states (Figure 6). The model applies specific transition probabilities based on sex and five-year age groups.

The transition probability from Healthy (A) to Poor mental health (B) and recovery from (B) to (A) was based on disease/recovery incidences in Skåne for mental health diagnoses (ICD10: F30-48), provided by Region Skåne.

The transition probability from Healthy (A) to Death (C) was derived from age- and sex-specific statistics on all-cause mortality from Statistics Sweden (SCB, 2024). The probability was adjusted for (B) to (C) to avoid double-counting deaths that occurred in the Poor mental health state. This was done by subtracting the proportion of deaths among those in the Poor mental health state from the all-cause mortality risk. The transition probability from Poor mental health (B) to Death (C) was calculated by applying age- and sex-specific hazard ratios of death from being in poor mental health (von Below et al., 2023) to the Swedish all-cause mortality.

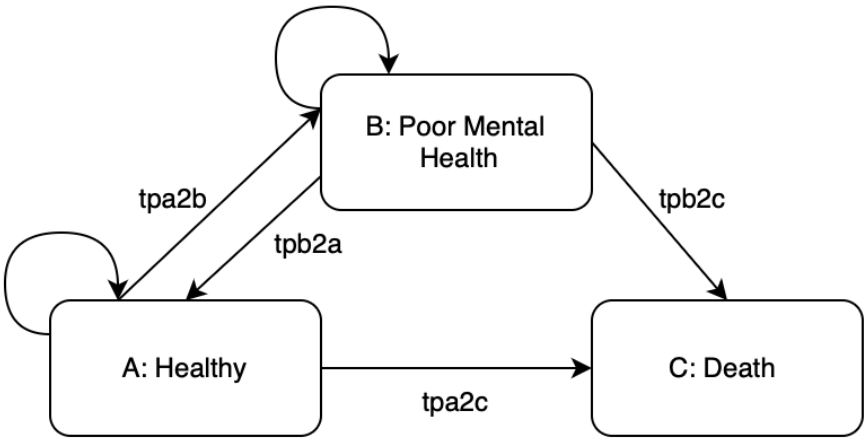

Figure 6: State transition diagram with transition probabilities

Since incidence rates (λ) reflect continuous-time risks, but the Markov model operates in discrete one-year cycles, any input rates were converted to annual transition probabilities using the standard formula (equation 1).

$$P = 1 - e^{-\lambda} \ (eq.1)$$

3.5.1 Baseline data and calculations not impacted by green space quality

The baseline data used for the transition probabilities were the mortality rate (SCB, 2024), hazard ratios on the increased risk of all-cause mortality from having anxiety (von Below et al., 2023), the incidence and prevalence rate of poor mental health and recovery rate from poor mental health, supplied by Region Skåne.

This section outlines the adjustments made to the baseline data in the model that is not related to the impact of green space quality. To improve clarity, this is illustrated in examples showing the calculations for women aged 20-24.

3.5.1.1 Baseline Mortality rate across Physical Activity Levels

The baseline mortality rates (SCB, 2024) are averages over the population and in order to get the mortality rates for each physical activity level group, we apply the hazard ratios for all-cause mortality in different physical activity groups from (Lear et al., 2017).

$$MR_{b\text{-}tot} = PALP_{b\text{-}low} * MR_{b\text{-}low} + PALP_{b\text{-}mid} * MR_{b\text{-}low} * HR_{mid} + PALP_{b\text{-}high} * MR_{b\text{-}low} * HR_{high} \quad \text{(eq. 2)}$$

Where MR is the mortality rate and PALP the proportion in the low, mid and high physical activity level groups. This rearranges into "eq. 2 simplified" in order to obtain the mortality rate for the low physical activity group:

$$MR_{b\text{-}low} = MR_{b\text{-}tot} / (PALP_{b\text{-}low} + PALP_{mid} * HR_{mid} + PALP_{b\text{-}high} * HR_{high}) \quad \text{(eq. 2 simplified)}$$

Example

Average baseline all-cause mortality for women aged 20-24 is $MR_{b\text{-}tot} = 0.00017$. The hazard ratio for women with high and mid physical activity, as compared to low, is $HR_{high} = 0.58$ and $HR_{mid} = 0.74$. Using eq. 2 simplified to calculate baseline mortality rate for those with low physical activity:

$$\frac{0.00017}{0.321 + 0.31*0.74 + 0.369 * 0.58} = 0.0002224 \quad \text{(eq. 2 simplified)}$$

This allows us to calculate the mortality rate of the remaining physical activity groups:

$$MR_{b\text{-}mid} = MR_{b\text{-}low} * HR_{mid} = 0.0002224 * 0.74 = 0.0001646$$

$$MR_{b\text{-}high} = MR_{b\text{-}low} * HR_{high} = 0.0002224 * 0.58 = 0.000129$$

Before implementation in the model, the mortality rates are transformed to incidence rates.

3.5.1.2 Baseline Odds of PMH across Physical Activity Levels

The baseline data on incidence of poor mental health is aggregated across physical activity levels, and in order to get the probability of poor mental health for the different physical activity groups we apply the odds of poor mental health in different physical activity levels from (Hamer et al., 2009). For this we will follow a similar approach as in section 3.5.1.1.

$Odds_{b\text{-}low} = Odds_{b\text{-}tot} / (PALP_{b\text{-}low} + PALP_{mid} * OR_{mid} + PALP_{b\text{-}high} * OR_{high})$ (eq. 3)

Where PALP is the proportion in the low, mid and high physical activity level groups.

Example

The average incidence rate of poor mental health for women aged 20-24 is $\lambda_{b\text{-}tot} = 0.0501$. The odds ratio of poor mental health associated with physical activity, with low physical activity as the reference group, is $OR_{mid} = 0.6$ and $OR_{high} = 0.49$.

Step 1: transform the incidence rate into probability ($P_{b\text{-}tot}$) using eq. 1:

$$P_{b-tot} = 1 - e^{-0.0501} = 0.0489$$

Step 2: transform probability into odds ($Odds_{b\text{-}tot}$):

$$Odds_{b-tot} = \frac{0.0489}{1 - 0.0489} = 0.0514$$

Step 3: apply equation 3:

$$Odds_{b-low} = \frac{0.05}{0.321 + 0.31*0.6 + 0.369 * 0.49} = 0.0728$$

3.5.1.3 Mortality rate for People with Poor Mental Health

The mortality rate of people with poor mental health is calculated by applying the hazard ratio from having anxiety (HR = 1.25) (von Below et al., 2023) to the baseline all-cause mortality.

Example

The baseline all-cause mortality for women 20-24 years of age is 0.00017. We get the transition probability from the Poor mental health state to Death by:

0.00017*1.25 = 0.0002125

3.5.2 Incorporating green space quality

3.5.2.1 Direct effect - Restorativeness

Restorativeness has only been found to be significantly associated with one PSD, Serene (Van den Bosch et al., 2015). Therefore, the model includes a direct effect of green space quality on the probability of recovery from Poor mental health (transition from state B to state A) only when the Serene dimension is present. Recovery rate was defined as the proportion in the affected population who did not have a diagnosis of anxiety or depression (F30-F48) in the last two years after a previous sickness spell.

In order to apply the effect on recovery as presented in (Van den Bosch et al., 2015), we first transformed the recovery rate to the probability of recovery (eq.1) and subsequently odds (eq. 4). We apply the odds ratio from (Van den Bosch et al., 2015) and transform back to probability of recovery.

$\frac{P}{1-P} = Odds$ (eq. 4)

Example

The recovery rate of women aged 20-24, as reported by Region Skåne, is 0.244. The odds ratio of Serene is 2.8.

$$0.244/(1 - 0.244) = 0.323$$

$$0.323 * 2.8 = 0.904$$

$$0.904/(1 + 0.904) = 0.475$$

Probability of recovery in the presence of Serene incorporated in the model is thus 0.475 compared to 0.244 without Serene.

3.5.2.2 Indirect effect - Physical activity

The condition for effects of number of PSDs on physical activity is limited to Natural (Na), Cultural (Cu), Serene (Se), Cohesive (Co) and Diverse (Di) (i.e., the 5 PSD included in the Scania green score) (Björk et al., 2008). The effects are presented as Odds Ratios (Table 2).

Table 2: The effects of GSQ in terms of number of PSD on physical activity.

	Odds ratio	**Low bound**	**High bound**
4-5 PSD	1.44	1.24	1.66
3 PSD	1.41	1.26	1.57
2 PSD	1.13	1.04	1.24
1 PSD	1.08	1.02	1.15

Note: The reference group is zero PSDs. Source Björk et al., 2008.

We model the effect of being exposed to a higher green space quality as a change in the proportion of the population in the three physical activity categories, which in turn affects the risk of poor mental health (tpa2b) using the results of (Hamer et al., 2009) and the risk of death if healthy (tpa2c) using the results of (Lear et al., 2017).

Because the study by (Björk et al., 2008) uses a logistic ordinal regression and the OR is defined as cumulative odds, baseline distribution must be used to correctly translate the OR into new category probabilities. Baseline physical activity category probabilities were converted into cumulative odds and multiplied by the effect of PSD from (Björk et al., 2008), and then transformed to category probabilities. By preserving the proportional-odds assumption, this method generates a physical activity distribution adjusted for exposure to PSD. The resulting physical activity proportions serve as weights when calculating the transition probabilities for poor mental health (A to B) and all-cause mortality (A to C) in the Markov model.

Example

In order to calculate the proportion in each physical activity level (PALP) adjusted for exposure to 1 PSD (OR=1.08), we apply the odds ratios from (Björk et al., 2008) to the baseline physical activity groups (as calculated in 3.5.1.1). We assume that the yearly proportions can be interpreted as probabilities. The baseline PALP for women 20-24 years of age is 0.321, 0.31, 0.369 for low, mid and high physical activity.

Step 1: Calculate cumulative probabilities

$CP_{mid} = 0.31+0.369=0.679$

$CP_{high} = 0.369$

Step 2: Transform the cumulative probabilities into cumulative odds

$CO_{mid} = 0.679/(1-0.679) = 2.1153$

$CO_{high} = 0.369/(1-0.369) = 0.5848$

Step 3: Apply PSD odds ratio to the cumulative odds

Adj $CO_{mid} = 2.1153*1.08 = 2.2845$

Adj $CO_{high} = 0.5848*1.08 = 0.6316$

Step 4: Transform to cumulative probabilities

Adj $CP_{mid} = 2.2845/(1+2.2845) = 0.6955$

Adj $CP_{high} = 0.6316/(1+0.6316) = 0.3871$

Step 5: Convert to category proportions

$PALP_{high}$ = Adj $CP_{high} = 0.3871$

$PALP_{mid} = 0.6955-0.3871 = 0.3084$

$PALP_{low}$ = 1-0.6955 = 0.3045

3.5.2.3 Adjusting for double counting in the transition from healthy to dead

The mortality will be overestimated if all-cause mortality (A to C) also includes the deaths from poor mental health (B to C). Thus, the transition probability A to C needs to be adjusted for the deaths in the Poor mental health state. We adjust the all-cause mortality by subtracting the product of the transition probabilities A to B and B to C. This is a simplification compared to a full calculation of competing risks (Briggs et al., 2006).

3.6 Outcomes

The model produces both health and health economic outcomes. Health outcomes are captured as the amount of time individuals spend in each health state (e.g., healthy, PMH, deceased) over the lifetime simulation. From these state occupancy data, the model estimates quality-adjusted life years (QALYs) and direct healthcare costs.

3.6.1 QALY

QALYs are calculated by applying health-state specific utility weights to each year spent in the respective state. This provides a summary measure that reflects both the quantity and quality of life. The weights were assigned based on the Swedish EQ-5D index values from (Lindkvist & Feldman, 2016). Poor mental health is defined as a GHQ12 score ≥ 3 with a weight of 0.81, while the weight for being in the health state is 0.91.

3.6.2 Healthcare costs

The average healthcare costs for individuals in Healthy state (A) were derived from publicly available data on mean healthcare expenditures per person and year by age group in Sweden SOU (2024:50).

Table 3: Healthcare costs in the Healthy state

Age group	Cost (SEK)
19-29	12 890
30-49	14 498
50-66	20 973
67-75	38 352
76-79	53 574
80-89	66 518
90+	75 478

Note: the costs used as healthcare costs consists of the mean healthcare costs in Sweden stratified by age groups. Source (SOU 2024:50).

3.6.3 Healthcare costs of having poor mental health

To estimate the direct health care costs of poor mental health, an excess cost of 42% was added to the healthcare cost of the healthy state (Łaszewska et al., 2020). Although this estimate was derived from Austrian data, it represents the best available evidence for this parameter.

3.6.4 End-of-Life Healthcare Costs

This cost is applied as a one-time cost when transitioning into the Death state (C), representing typical healthcare expenditures incurred shortly before death. Due to the lack of recent Swedish data, end-of-life healthcare costs were derived from a Norwegian study (Michel et al., 2024), which reported average healthcare expenditure of €46,166 per person during the final six months of life. This was adjusted using Price Level Index for health (EU27 = 100), health expenditure group A0106 (SSB, 2025).

3.7 Sensitivity Analysis

A one-way deterministic sensitivity analysis was conducted for the model's key inputs: the effects on physical activity and mental health from a change in PSDs. We used the confidence intervals provided for the effect measures, see Table 4 (Björk et al., 2008; Van den Bosch et al., 2015).

Table 4: Key input variables for the model on the effect of PSDs on health

	Base case	Low bound	High bound
Björk et al., 2008			
4-5 PSDs	1.44	1.24	1.66
3 PSDs	1.41	1.26	1.57
2 PSDs	1.13	1.04	1.24
1 PSDs	1.08	1.02	1.15
Van den Bosch et al., 2015			
Serene is present	2.8	1.11	7.04

Notes: Table shows the base case values and the values from the 95% confidence intervals given in the studies (Björk et al., 2008; Van den Bosch et al., 2015).

4. Results

The model presents the lifetime QALY and lifetime total healthcare costs for the population now living within a 300m buffer from the green space in question.

Table 5 presents the assessments of the Perceived Sensory Dimensions (PSD) for the current situation at six different locations in Skåne, as well as an assessment of how design proposals affect the qualities of the green spaces. The assessment of the design proposals generally shows improved quality, even if certain dimensions decrease, often in line with an increase in the oppositional PSD. The locations exhibit varying PSD profiles; some environments are dominated by Natural and Cohesive, while others are characterized by Social and Diverse. A clear example is Dalen in Örkelljunga, which is nature-oriented and cohesive but completely lacks social elements. The Skansen area in Simrishamn shows the opposite pattern, with high values for Social and Diverse and low values for Serene and Sheltered (Eriksson et al., 2026).

The analysis shows that Natural and Serene often occur together, as do Cultivated and Social, suggesting that natural environments are perceived as calm and that cultivated environments attract social interaction. At the same time, clear oppositional relationships emerge: nature-oriented environments stand in contrast to cultural and open environments, and Cultivated correlates negatively with both Cohesive and Serene. This indicates that livelier cultural environments are perceived as less calm and less cohesive (Eriksson et al., 2026).

Table 5: Estimates of Perceived Sensory Dimensions for the Design Proposals and Current Situation

	Natural	Cultural	Cohesive	Diverse	Sheltered	Open	Serene	Social
Malmö								
Current situation	**1**	**2**	**1**	**2**	1	2	**2**	3
Safiren	**1**	**3**	**2**	**2**	2	2	**2**	3
Blå gården	**2**	**2**	**3**	**3**	3	2	**3**	2
Hässleholm								
Current situation	**1**	**1**	**1**	**2**	0	3	**1**	2
Ljungdala naturstråk	**2**	**1**	**2**	**3**	2	2	**2**	3
Ljungdala Idrottsstråk	**1**	**1**	**2**	**2**	0	3	**0**	3
Eslöv								
Current situation	**2**	**0**	**2**	**1**	2	2	**2**	1
Onsjö aktivitetspark	**3**	**0**	**3**	**1**	2	2	**1**	3
Kontemplationsparken	**1**	**3**	**3**	**1**	2	2	**2**	3
Simrishamn								
Current situation	**1**	**2**	**0**	**2**	0	3	**1**	2
Havsstråket	**2**	**2**	**2**	**3**	1	2	**2**	3
Stationsnära Aktivitetshub	**1**	**2**	**1**	**2**	1	2	**1**	3
Örkelljunga								
Current situation	**2**	**1**	**3**	**0**	2	1	**1**	0
Pe-dalen	**1**	**1**	**3**	**1**	1	2	**0**	2
Naturen lär	**2**	**2**	**3**	**2**	3	0	**2**	1
Höganäs 4								
Current situation	**0**	**1**	**3**	**0**	0	3	**0**	0
Grönt pärlband	**2**	**1**	**3**	**2**	2	2	**2**	1
Art walk	**0**	**3**	**3**	**2**	0	3	**0**	2

Notes: The perceived sensory dimensions included in the model (as part of the Skåne Green Score) are shown in **bold**.

Data regarding population size and demographics within 300 meters of each design proposal has been provided by the Social Analysis Unit at Region Skåne, disaggregated by gender and 5-year age groups. This was performed by buffering the areas specified in the report *Hälsofrämjande utemiljöer i samverkan* by 300 meters and overlaying these with 100-meter grid cells (Region Skåne, 2025). Only grid cells where 30% or more of the area is covered by the buffer were included in the analysis.

To calculate the outcomes for each design proposal, we integrated the demographic and geographical data with the corresponding demographic-specific model scenarios. This allowed us to estimate the total costs and total QALYs for both the current situation and the proposed designs. By comparing the proposals to the current situation, we quantified the net impact on societal costs and health outcomes. These results reflect the expected effects on mental health and all-cause mortality, occurring both directly through psychological restoration and indirectly through increased physical activity.

The results are presented by area and design proposal, with each scenario compared to the current situation. Differences in total and per-person costs and QALYs are reported, together with lower and upper estimates based on the 95% confidence interval of the effects of PSDs on restoration and physical activity.

Table 6 presents the model simulation results for each design proposal. Improvements in the quality of residential green space are, in most cases, associated with increased quality of life (QALYs) and, in several cases, reduced healthcare costs. Particularly large QALY gains are observed in proposals that introduce the Serene PSD. Overall, a higher number and broader composition of PSDs are associated with greater QALY gains, although results vary between areas and proposals due to differences in baseline conditions and the scope of the interventions. The magnitude and direction of cost differences also vary between areas and proposals, partly reflecting differences in survival and time spent in healthcare consuming health states, as well as the extent of the proposed changes.

Table 6: Model-based estimation of the effects of changes in PSDs in the design proposals within the project Health-Promoting Outdoor Environments in Skåne (2024).

Design proposal	PSD scenario change	Total cost-difference (million SEK) [sensitivity lower bound-upper bound]	Total QALY-difference [lower bound-upper bound]	Total cost-difference per person (thousand SEK) [lower bound-upper bound]	QALY difference per person [lower bound-upper bound]
Malmö Safiren	PSD3s -> PSD4s	-0.8	20	-0.21	0.01
		[0.5; -2.2]	[-15; 51]	[0.14; -0.56]	[0.00; 0.01]
Malmö Blå gården	PSD3s -> PSD4s	-0.8	20	-0.21	0.01
		[0.5; -2.2]	[-15; 51]	[0.14; -0.56]	[0.00; 0.01]
Ljungdala naturstråk	PSD1 -> PSD4s	10.4	414	4.35	0.17
		[-2.2; 18.1]	[154; 501]	[-0.93; 7.61]	[0.06; 0.21]
Ljungdala idrottsstråk	PSD1 -> PSD2	-1.1	28	-0.46	0.01
		[-0.5; -1.8]	[12; 46]	[-0.19; -0.75]	[0.01; 0.02]
Eslöv Onsjö aktivitetspark	PSD3s -> PSD2	-8.1	-233	-5.23	-0.15
		[1.0; -13.9]	[-92; -265]	[0.63; -8.97]	[-0.06; -0.17]
Eslöv Kontemplationspark	PSD3s -> PSD3s	0	0	0	0
Simrishamn Havsstråket	PSD2 -> PSD4s	4.2	190	3.76	0.17
		[-1.53; 8.42]	[74; 221]	[-1.37; 7.54]	[0.07; 0.20]
Simrishamn Aktivitetshub	PSD2 -> PSD2	0	0	0	0
Örkelljunga Pe-dalen	PSD2 -> PSD1	0.6	-15	0.49	-0.01
		[0.25; 0.97]	[-6; -24]	[0.21; 0.81]	[-0.01; -0.02]
Örkelljunga Naturen lär	PSD2 -> PSD4s	5.4	195	4.47	0.16
		[-1.07; 9.64]	[73; 230]	[-0.89; 8.05]	[0.06; 0.19]
Höganäs 4 Pilbågen	PSD1 -> PSD4s	2.1	118	3.13	0.18
Grönt pärlband		[-1.04; 4.28]	[47; 141]	[-1.55; 6.39]	[0.07; 0.21]
Höganäs 4 Pilbågen	PSD1 -> PSD3	-2.3	53	-3.46	0.08
Art walk		[-1.83; -2.68]	[42; 61]	[-2.73; -4.00]	[0.06; 0.09]

Notes: Results from the sensitivity analysis, in which the confidence intervals from the effect studies were used, are presented in parentheses. For the Höganäs design proposals a sub-area was analysed (Höganäs 4, Pilbågen; see Appendix 1)

4.1 Malmö, Bostadsgård, Lorensborg and the Stadion Area

Two design proposals were analysed for the Malmö area: Safiren and Blå gården, both corresponding to a PSD4s scenario compared with the current situation (PSD3s), resulting in QALY gain of approximately 20 QALYs (0.01 per person). The cost difference in healthcare costs estimated an increase in costs of approximately SEK 0.8 million (SEK 210 per person). The results indicate potential health gains in QALY and potential higher healthcare costs, but with considerable uncertainty.

4.2 Hässleholm, Ljungdala

In Hässleholm, two design proposals were compared with the current situation (PSD1): Ljungdala Naturstråk (PSD4s) and Ljungdala Idrottsstråk (PSD2). The Naturstråk showed the largest effects among all analysed areas, with a total cost saving of approximately SEK 10.4 million and a total QALY gain of 414. This corresponded to a cost saving per person of approximately SEK 4,350 and a QALY gain per person of 0.17. The Idrottsstråk resulted in negative effects, with a total cost difference of approximately SEK -1.1 million but a positive total QALY gain of 28. Per person, this corresponds to approximately SEK -460 and 0.01 QALYs. Overall, the results indicate that the magnitude of PSD improvements has a substantial influence on the model outcomes.

4.3 Eslöv, Onsjöparken

Two design proposals were analysed in Eslöv: Onsjö aktivitetspark (PSD2) and Kontemplationspark (PSD3s), compared with the current situation (PSD3s). Onsjö aktivitetspark resulted in negative effects, with a total cost increase of approximately SEK 8.1 million and a total QALY loss of 233. This corresponds to a cost increase per person of approximately SEK 5,230 and QALY loss per person of 0.04. The Kontemplationspark showed no differences compared with the current situation in terms of costs or QALYs, reflecting that the PSD scenario remained unchanged.

4.4 Simrishamn, Skansen

The area in Simrishamn, Havsstråket (PSD4s) and the Aktivitetshub (PSD2) were analysed and compared with the current situation (PSD2). Havsstråket showed positive effects, with a total cost saving of approximately SEK 4.2 million and a total QALY gain of 190. Per person, this corresponds to approximately SEK 3,760 and 0.17 QALYs. For the Aktivitetshub, no differences in costs or QALYs were observed, as the PSD level was the same as in the current situation.

4.5 Örkelljunga, Dalen

Two design proposals were analysed in Örkelljunga: Pe-dalen (PSD1) and Naturen lär (PSD4s), compared with the current situation (PSD2). Pe-dalen resulted in positive cost difference with a total cost decrease of approximately SEK 0.6 million but a total QALY loss of 15. In contrast, the design proposal Naturen lär produced positive results for both costs and QALY, with a total cost saving of approximately SEK 5.4 million and a total QALY gain of 195. Per person, this corresponds to approximately SEK 4,470 and 0.16 QALYs.

4.6 Höganäs, Pilbågen

Two design proposals were analysed for the Pilbågen sub-area (Höganäs 4): Grönt pärlband (4 PSD) and Art Walk (3 PSD), compared with the baseline (1 PSD). The Grönt pärlband resulted in total cost savings of SEK 2.1 million and a total QALY gain of 118. Per person, this corresponds to SEK 3,130 and 0.18 QALYs. Art Walk resulted in smaller health gains, with a total increase of 53 QALYs (0.08 per person), but was associated with higher healthcare costs, with a total increase of SEK 2.3 million (SEK 3,460 per person).

5. Discussion

5.1 Summary of findings

Overall, the results indicate that design proposals involving an increase in the number of PSDs are generally associated with positive health effects, particularly when measured in terms of QALYs. At the same time, the results show both increases and decreases in healthcare costs across the different scenarios. This reflects a key structural feature of the model: most healthcare costs are accumulated while individuals remain alive, meaning that earlier mortality mechanically leads to lower healthcare expenditures. Consequently, interventions that reduce mortality may increase lifetime healthcare costs, even when they generate substantial health gains. Importantly, this perspective does not account for the broader economic and societal costs associated with premature death, such as productivity losses and the value of lost life-years, which are not included in the present analysis but would be relevant in a more comprehensive societal evaluation. Design proposals that add the PSD Serene stand out, resulting in positive effects. In most of the analysed areas, a higher number and a broader composition of PSDs lead to greater QALY gains, both in total and per person. However, the results vary across areas and design proposals, reflecting differences in both the current situation and the scope of the proposed interventions.

5.2 Interpretation of the results

An exception to the overall pattern is observed in the comparison between PSD3 and PSD4 scenarios for the lower bound estimates. In these cases, the estimated health effects are slightly lower for PSD4 than for PSD3. This is explained by the fact that the lower bound of the association between physical activity and PSDs is set at 0.26 for PSD3, compared with 0.24 for PSD4. The difference therefore reflects the model parametrization and should be interpreted with caution.

5.3 Limitations

First, the cost components included in the model do not capture the full range of effects that improvements in green space quality are expected to have on the population. While the analysis includes healthcare costs associated with morbidity and mortality, it does not incorporate broader societal impacts such as productivity gains, mental well-being beyond healthcare use, or other non-health benefits of access to high-quality green environments. As a result, the estimated economic effects should be interpreted as partial rather than comprehensive societal costs and benefits.

Second, due to the censoring of small population clusters in Statistics Sweden (SCB) data, the number of individuals living within 300 meters of each green space may be underestimated. This implies that the total health and cost effects reported here are likely conservative. In addition, the use of a 300-meter buffer as the inclusion criterion introduces further uncertainty. Proximity within 300 meters does not guarantee actual exposure or use, while individuals living beyond this distance may still regularly visit and benefit from the green space. This binary definition of exposure therefore simplifies a more complex spatial and behavioral reality.

Third, the on-site PSD assessments were conducted during winter, and it remains unclear to what extent seasonal variation affects the classification of perceived sensory dimensions. Green space qualities, vegetation, and user experience may differ substantially across seasons. Ideally, PSD assessments would be conducted at multiple time points throughout the year to improve validity. At the same time, winter usability is itself an important aspect of green space quality in a Nordic context, particularly given the prevalence of seasonal affective symptoms.

Fourth, the model assumes homogeneous effects across individuals and does not account for unmeasured confounders such as socioeconomic status, baseline health, or differences in mobility and green space use. All individuals within the 300-meter buffer are assumed to have equal exposure, which may over- or underestimate effects for specific subgroups. Moreover, the model relies on a static representation of exposure and health effects, without accounting for changes in population composition, behavior, or green space use over time.

Finally, as with any modelling study, the results depend on the structure of the model and the assumptions embedded in it. The relationships between PSDs, health outcomes, and costs are derived from observational data and applied within a simplified representation of long-term health dynamics. Although sensitivity analyses were conducted to explore parameter uncertainty, the findings should be interpreted as scenario-based estimates rather than precise predictions of real-world outcomes.

5.4 Methodological considerations

The results should be interpreted with caution, as there are several aspects that need to be considered. The causal effects of changes in PSDs are not well studied, and the model is based on associative relationships. Furthermore, the results are sensitive to certain assumptions, and additional sensitivity analyses should be carried out to test robustness. Finally, formal model validation against external data or comparable studies would substantially strengthen the credibility and robustness of the results.

5.5 Policy implications

Our findings illustrate the potential value of investing in green space improvements. Municipalities could in the future use GIS data on population distribution within 300 meters of a green space, stratified by age and gender, to estimate potential health and cost effects of specific interventions on green spaces with this model. By translating "soft" values, such as mental and physical health gains, into monetary terms, decisionmakers can compare the costs of park renovations to expected savings in healthcare and improvements in quality of life.

5.6 Future research

This report presents the first version of the model and does not provide a complete picture of all costs and effects. For the model to reach its full potential, further development is needed, including:

- Including more health outcomes (e.g., cardiovascular disease) and the effects of reduced air pollution.
- Including impacts on municipal costs (e.g., health and social care).
- Including productivity gains from reduced morbidity.
- Improving data quality, especially regarding causal health effects of experiential values.
- Conducting model validation and additional sensitivity analyses.
- Integrating GIS-based analyses for more accurate exposure assessment (could be done through spatial microsimulation).
- Analysing how changes affect the distribution of health across different population groups.
- Allow exposure to vary over group characteristics (e.g., sex, age, socioeconomic status).

Furthermore, allowing both distance to, and size of, green spaces to vary would enable a more realistic representation of exposure. However, this would require additional research on how changes in PSDs interact with distance and green space size to influence health outcomes.

6. Conclusions

This report demonstrates that improvements in residential green space can be valued in monetary terms by quantifying both healthcare costs and quality-adjusted life years (QALYs) through the operationalization of perceived sensory dimensions (PSDs). By linking changes in the number and composition of PSDs to health outcomes, the model translates otherwise "soft" benefits of urban greenery into tangible, policy-relevant metrics. While this model does not capture all societal benefits, it represents an important step towards enabling the costs of park renovation or design interventions to be weighed against potential healthcare savings and gains in quality of life, supporting more informed decisions on investments in green infrastructure.

References

Björk, J., Albin, M., Grahn, P., Jacobsson, H., Ardö, J., Wadbro, J., & Ostergren, P. O. (2008). Recreational values of the natural environment in relation to neighbourhood satisfaction, physical activity, obesity and wellbeing. *J Epidemiol Community Health*, *62*(4), e2. https://doi.org/10.1136/jech.2007.062414

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J. J., Hartig, T., Kahn, P. H., Kuo, M., Lawler, J. J., Levin, P. S., Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J.,…Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science advances*, *5*(7), eaax0903. https://doi.org/doi:10.1126/sciadv.aax0903

Briggs, A., Sculpher, M., & Claxton, K. (2006). *Decision modelling for health economic evaluation*. Oup Oxford.

Briggs, A. D., Wolstenholme, J., Blakely, T., & Scarborough, P. (2016). Choosing an epidemiological model structure for the economic evaluation of non-communicable disease public health interventions. *Popul Health Metr*, *14*, 17. https://doi.org/10.1186/s12963-016-0085-1

Caro, J. J., Briggs, A. H., Siebert, U., & Kuntz, K. M. (2012). Modeling Good Research Practices—Overview: A Report of the ISPOR-SMDM Modeling Good Research Practices Task Force-1. *Value in Health*, *15*(6), 796–803. https://doi.org/https://doi.org/10.1016/j.jval.2012.06.012

de Jong, K., Albin, M., Skärbäck, E., Grahn, P., & Björk, J. (2012). Perceived green qualities were associated with neighborhood satisfaction, physical activity, and general health: Results from a cross-sectional study in suburban and rural Scania, southern Sweden. *Health & Place*, *18*(6), 1374–1380. https://doi.org/https://doi.org/10.1016/j.healthplace.2012.07.001

Diaby, V., Adunlin, G., & Montero, A. J. (2014). Survival modeling for the estimation of transition probabilities in model-based economic evaluations in the absence of individual patient data: a tutorial. *PharmacoEconomics*, *32*(2), 101–108. https://doi.org/10.1007/s40273-013-0123-9

Eriksson, L., Hansson, A., & Larsson, S. (2026). *Hälsofrämjande utemiljöer i Region Skåne*.

Folkhälsomyndigheten. (2015). *Fysisk aktivitet (självrapporterat) efter ålder, kön och år. Andel (procent)*. (

Gidwani, R., & Russell, L. B. (2020). Estimating Transition Probabilities from Published Evidence: A Tutorial for Decision Modelers. *PharmacoEconomics*, *38*(11), 1153–1164. https://doi.org/10.1007/s40273-020-00937-z

Grahn, P., & Stigsdotter, U. K. (2010). The relation between perceived sensory dimensions of urban green space and stress restoration. *Landscape and Urban Planning*, *94*(3), 264–275. https://doi.org/https://doi.org/10.1016/j.landurbplan.2009.10.012

Hamer, M., Stamatakis, E., & Steptoe, A. (2009). Dose-response relationship between physical activity and mental health: the Scottish Health Survey. *British journal of sports medicine*, *43*(14), 1111–1114.

Łaszewska, A., Wancata, J., Jahn, R., & Simon, J. (2020). The excess economic burden of mental disorders: findings from a cross-sectional prevalence survey in Austria. *Eur J Health Econ*, *21*(7), 1075–1089. https://doi.org/10.1007/s10198-020-01200-0

Lear, S. A., Hu, W., Rangarajan, S., Gasevic, D., Leong, D., Iqbal, R., Casanova, A., Swaminathan, S., Anjana, R. M., Kumar, R., Rosengren, A., Wei, L., Yang, W., Chuangshi, W., Huaxing, L., Nair, S., Diaz, R., Swidon, H., Gupta, R.,…Yusuf, S. (2017). The effect of physical activity on mortality and cardiovascular disease in 130 000 people from 17 high-income, middle-income, and low-income countries: the PURE study. *Lancet*, *390*(10113), 2643–2654. https://doi.org/10.1016/s0140-6736(17)31634-3

Lindkvist, M., & Feldman, I. (2016). Assessing outcomes for cost-utility analysis in mental health interventions: mapping mental health specific outcome measure GHQ-12 onto EQ-5D-3L. *Health and Quality of Life Outcomes*, *14*(1), 134. https://doi.org/10.1186/s12955-016-0535-2

Michel, Y. A., Aas, E., Augestad, L. A., Burger, E., Thoresen, L., & Bjørnelv, G. M. W. (2024). Healthcare use and costs in the last six months of life by level of care and cause of death. *BMC Health Services Research*, *24*(1), 688. https://doi.org/10.1186/s12913-024-10877-5

Microsoft Excel. In. (2024). (Version 16.89.1 (24091630)) Microsoft. https://www.microsoft.com/sv-se/microsoft-365/excel?market=se

Region Skåne. (2025). *Hälsofrämjande utemiljöer i samverkan*.

SCB. (2024). *Mortality rate, number by region, sex, age and year*

SCB. (2025). *CPI, Fixed Index Numbers (1980=100)*

SOU. (2024:50). *Nätt och jämnt Likvärdighet och effektivitet i kommunsektorn del 1* Statens offentliga utredningar Retrieved from https://www.regeringen.se/contentassets/384c4d51c81a43dea15b7c53bcea3a8e/natt-och-jamnt--likvardighet-och-effektivitet-i-kommunsektorn-sou-202450-del-1.pdf

SSB. (2025). 13007: Purchasing power parities, price level indices and real expenditures, by expenditure group and country (EU27) 2009 - 2023. In: Statistics Norway.

Stoltz, J., & Grahn, P. (2021). Perceived sensory dimensions: An evidence-based approach to greenspace aesthetics. *Urban Forestry & Urban Greening*, *59*, 126989. https://doi.org/https://doi.org/10.1016/j.ufug.2021.126989

Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environ Res*, *166*, 628–637. https://doi.org/10.1016/j.envres.2018.06.030

Van den Bosch, M. A., Östergren, P.-O., Grahn, P., Skärbäck, E., & Währborg, P. (2015). Moving to Serene Nature May Prevent Poor Mental Health—Results from a Swedish Longitudinal Cohort Study. *International Journal of Environmental Research and Public Health*, *12*(7), 7974–7989.

von Below, A., Hällström, T., Sundh, V., Björkelund, C., & Hange, D. (2023). Association between anxiety and depression and all-cause mortality: a 50-year follow-up of the Population Study of Women in Gothenburg, Sweden. *BMJ Open*, *13*(11), e075471. https://doi.org/10.1136/bmjopen-2023-075471

WHO. (2016). *Urban green spaces and health* (Urban green spaces and health, Issue.

Zhang, L., Tan, P. Y., & Diehl, J. A. (2017). A conceptual framework for studying urban green spaces effects on health. *Journal of Urban Ecology*, *3*(1). https://doi.org/10.1093/jue/jux015

Appendix 1

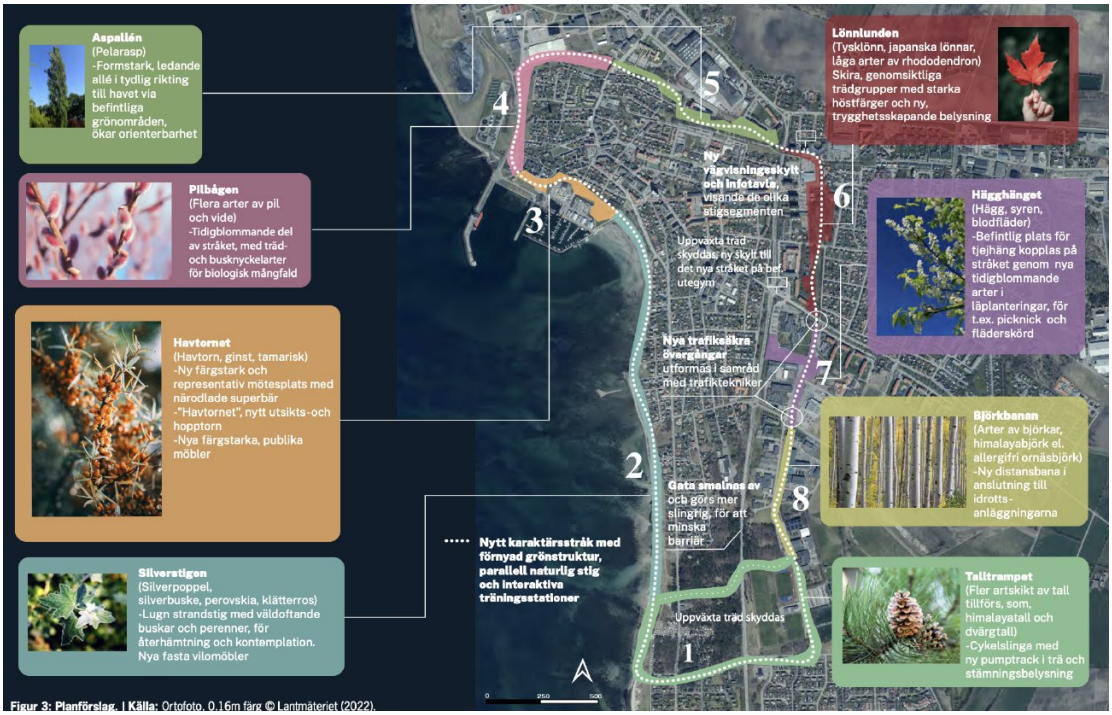

Figure 1: Gestaltningsförslaget *Grönt pärlband*, Höganäs

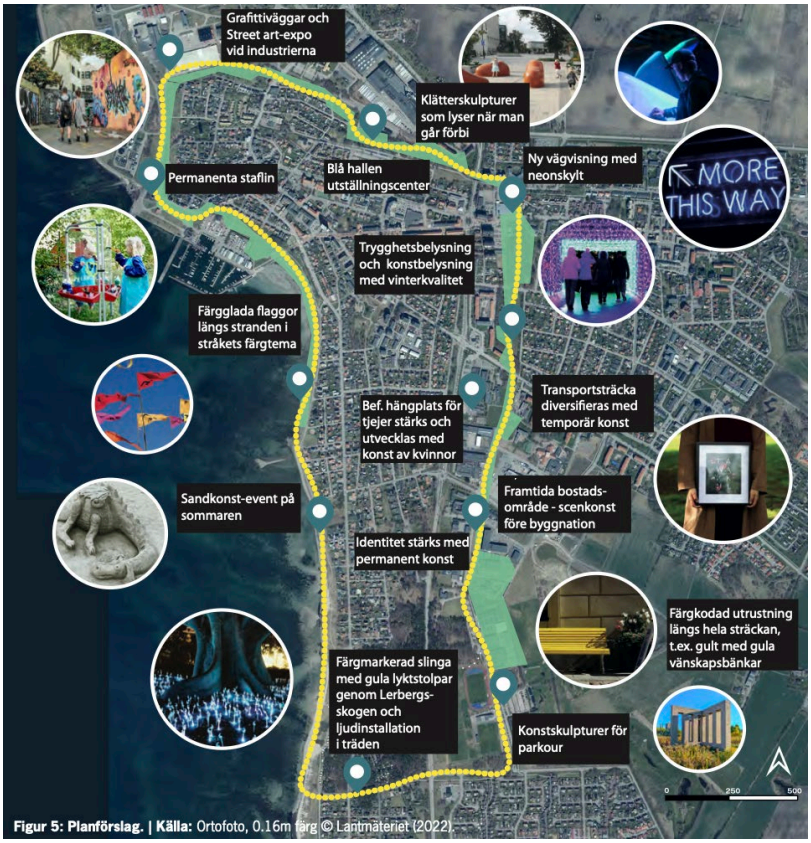

Figure 2: Gestaltningsförslaget *Art walk*, Höganäs