The cost-effectiveness of myopia control to retard the progression from high myopia

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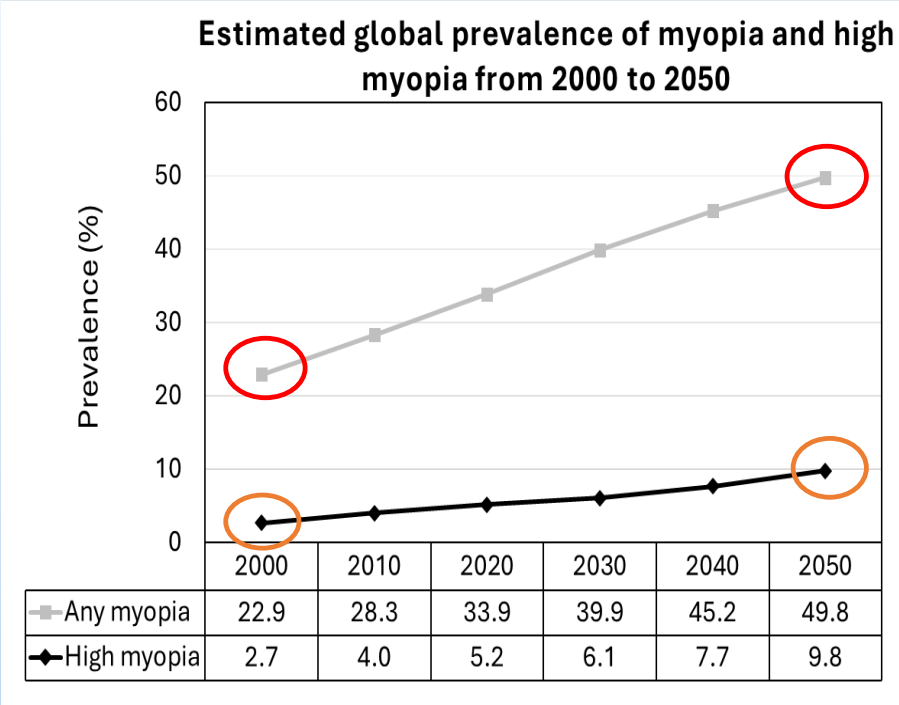
Background

• Growing prevalence of myopia



(Holden et al. 2016)

Prevalence of myopia among children in Hong Kong

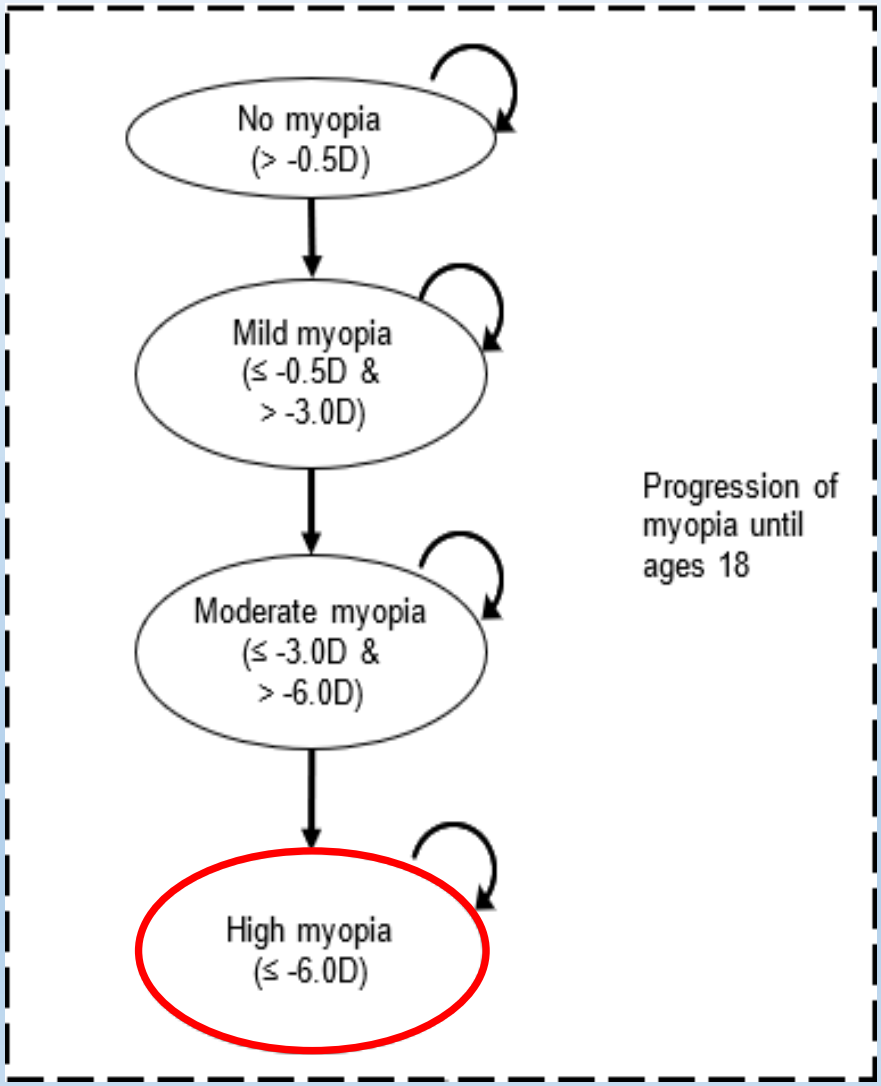
Study	Age	Prevalence
Choy et al. (2020)	6-13	Overall = 37.7% Grade 1: 13.3%, Grade 2: 30.0% Grade 3: 42.7%, Grade 4: 38.1% Grade 5: 53.6%, Grade 6: 54.7%

- **High myopia is associated with increased risk of ocular complications**

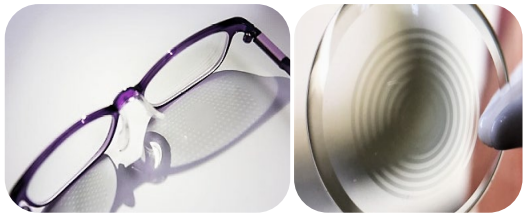
Meta-analysis (Haarman et al. 2020)

	Odds ratio				
	Nuclear cataract	Cortical cataract	Posterior subcapsular cataract	Open angle glaucoma	Retinal Detachment
Mild myopia	1.79	0.99	1.56	1.59	3.15
Moderate myopia	2.39	1.06	2.55	2.92	8.74
High myopia	2.87	1.07	4.55	2.92	12.62

• Myopic control to slow down the progression



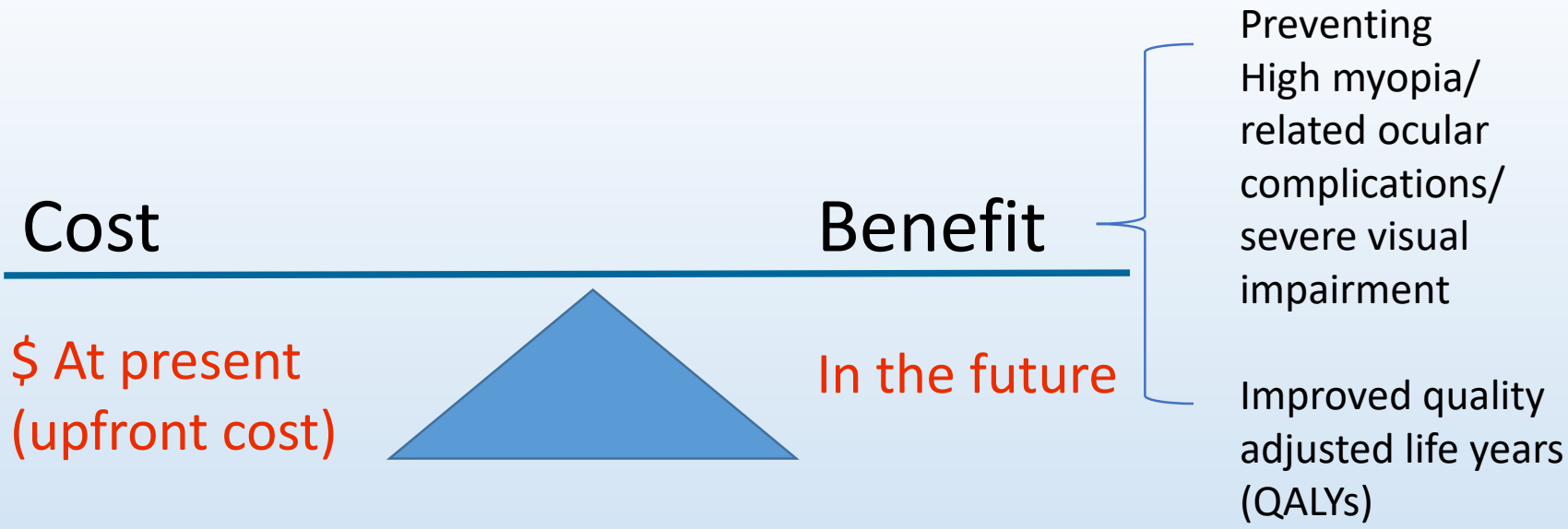
Optical



- Spectacle
- Contact lenses

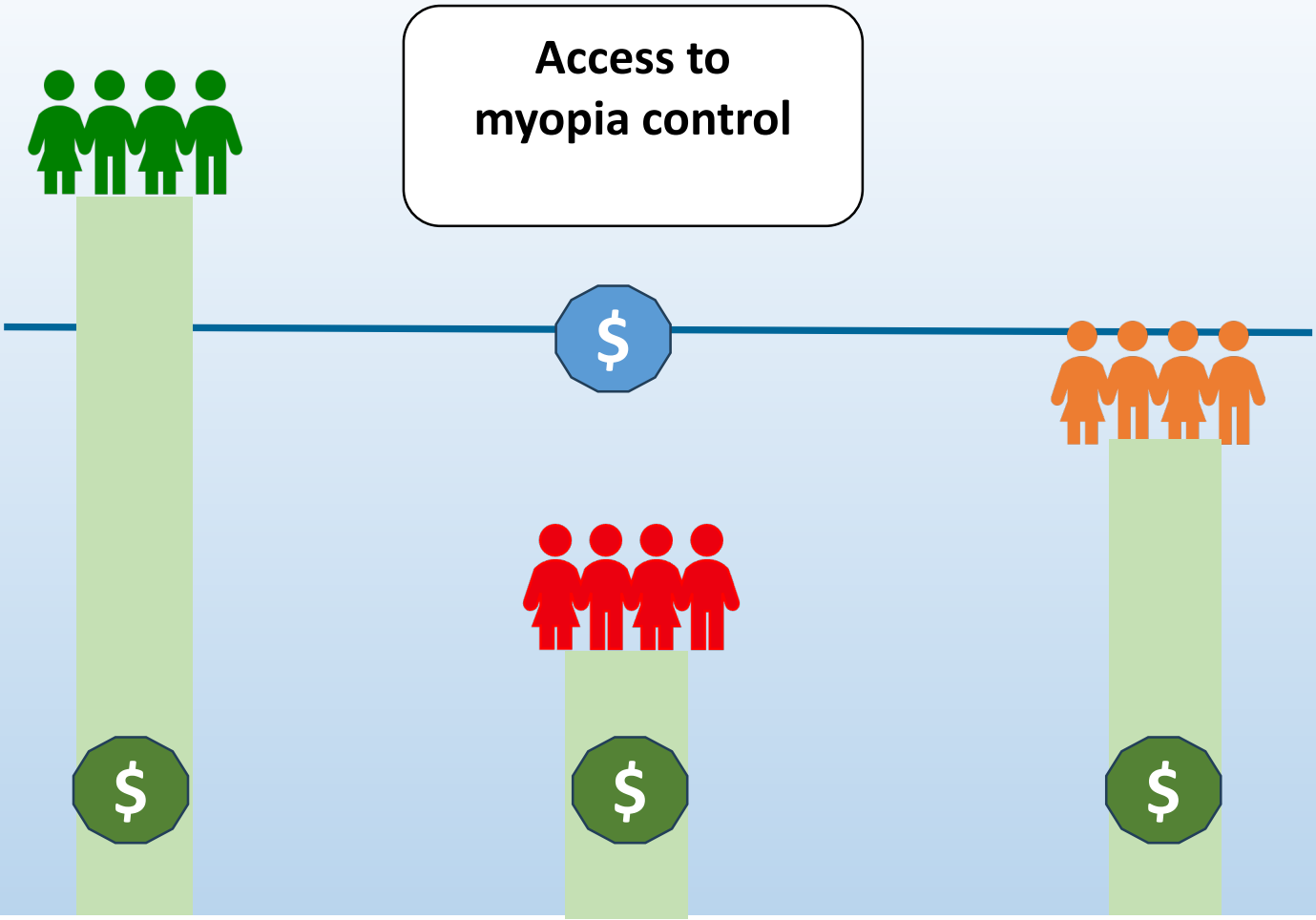
Pharmacological

- atropine



Economic questions :

Q1. Is the potential benefit from myopia control worth the resources that it would cost (i.e. value for money) from a societal perspective?



Economic questions :

Q2. If it is value for money, would it be cost-effective to subsidise myopia control for children from the government perspective?

Aim: To evaluate the cost-effectiveness of myopia control through optical approach in children

Objectives:

1) To build a cost-effectiveness model to determine whether myopia control is value for money from a societal perspective;
2) To examine whether subsidising myopia control is cost-effective from a government perspective to enable equitable access

Methods

- **Myopia control intervention**

  - Defocus Incorporated Multiple Segment (**DIMS**), spectacle lenses as an example

  - Slow myopia progression in spherical equivalent refraction (SER) by **52%** *(Lam et al. 2020)*

  - Provide to eligible children
    - Aged 6 to 15
    - SER -6.0 to -0.5 D

  - Package cost around HK$4,000 (including a pair of lenses and one follow-up at 6-month)

- **Compared strategies**

Q1. Is myopia control value for money from a **societal** perspective?

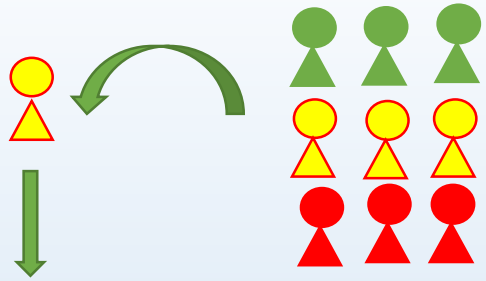
Strategy 1	Strategy 2
Myopia control (100% uptake)	No myopia control (0% uptake)

Q2. If it is value for money, would it be cost-effective to subsidise myopia control for children from the **government** perspective?

Strategy 1	Strategy 2
Full subsidy (80% uptake)	No subsidy (10% uptake)

- **Cost-effectiveness modelling**

  - an individual-based state-transition model
  - based on natural disease progression
  - simulate the impact across life time



100,000 children differ in:
- Age (6 to 11)
- Myopia level

Phase 1 (childhood)

Phase 2 (adulthood)

No myopia (< -0.5D)

Mild myopia (≤ -0.5D & > -3.0D)

Moderate myopia (≤ -3.0D & > -6.0D)

High myopia (≤ -6.0D)

Progression of myopia until ages 18

Ages ≥ 18 at different level of myopia, without any eye diseases

Eye diseases related to myopia:

1. Cataract
2. Glaucoma
3. Retinal detachment
4. Myopia macular degeneration

Impact on visual acuity (VA):

20/25 VA
20/40 VA
20/80 VA
20/200 VA
20/400 VA

Death according to age-specific mortality from lifetable

• Model Parameters – effectiveness

Local data:

- Prevalence and progression of myopia
- Effectiveness of DIMS lens
- Compliance rate: myopia control, referral and follow up for ocular complications
- Mortality rate

Overseas data:

- Annual transition probabilities
- Impact of ocular complications on visual acuity
- Utility decrement: severity of myopia, ocular complications and severe visual impairment

• Model parameters – costing (local data)

List of costs considered under each perspective

		Societal perspective	Government perspective
1)	**Direct cost**: optical correction due to myopia	✓	×
2)	**Direct cost** • myopia control intervention • treatment for myopia-related eye diseases	✓	✓
3)	**Productivity loss** • severe visual impairment	✓	×
4)	**Patient cost** • time and travelling cost • Informal care	✓	×
5)	**Co-payment** for ophthalmologist follow up / treatment	×	✓
6)	**Disability allowance** from Government	×	✓

- Incremental cost-effectiveness ratio (ICER)

$$\text{ICER} = \frac{\text{Difference in costs between A \& B (A-B)}}{\text{Difference in benefits between A \& B (A-B)}}$$

Extra cost for extra unit of benefit, i.e. cost per extra quality-adjusted life year (QALY) gained

- Both cost and effectiveness discounted at 3.5%

- One-way and probabilistic sensitivity analysis

Results

Part 1. Is myopia control value for money from a societal perspective?

Table 1: Estimated vision problems developed over lifetime with myopia control using DIMS and without control

Proportion	Without myopia control (0% uptake)	With myopia control (100% uptake)
High myopia	10.7%	5.9% ↓
Cataract	72.6%	71.6% ↓
Retinal detachment	2.2%	1.8% ↓
Myopic macular degeneration	6.5%	5.5% ↓
Open angle glaucoma	7.0%	6.3% ↓
Severe visual impairment (VA <20/200)	2.7%	2.2% ↓

Myopia control intervention can reduce (per 100,000 children)

~ 4800 high myopia

~ 500 severe visual impairment

Table 2: Long-term costs and consequences of myopia control using DIMS and no myopia control from the societal perspective

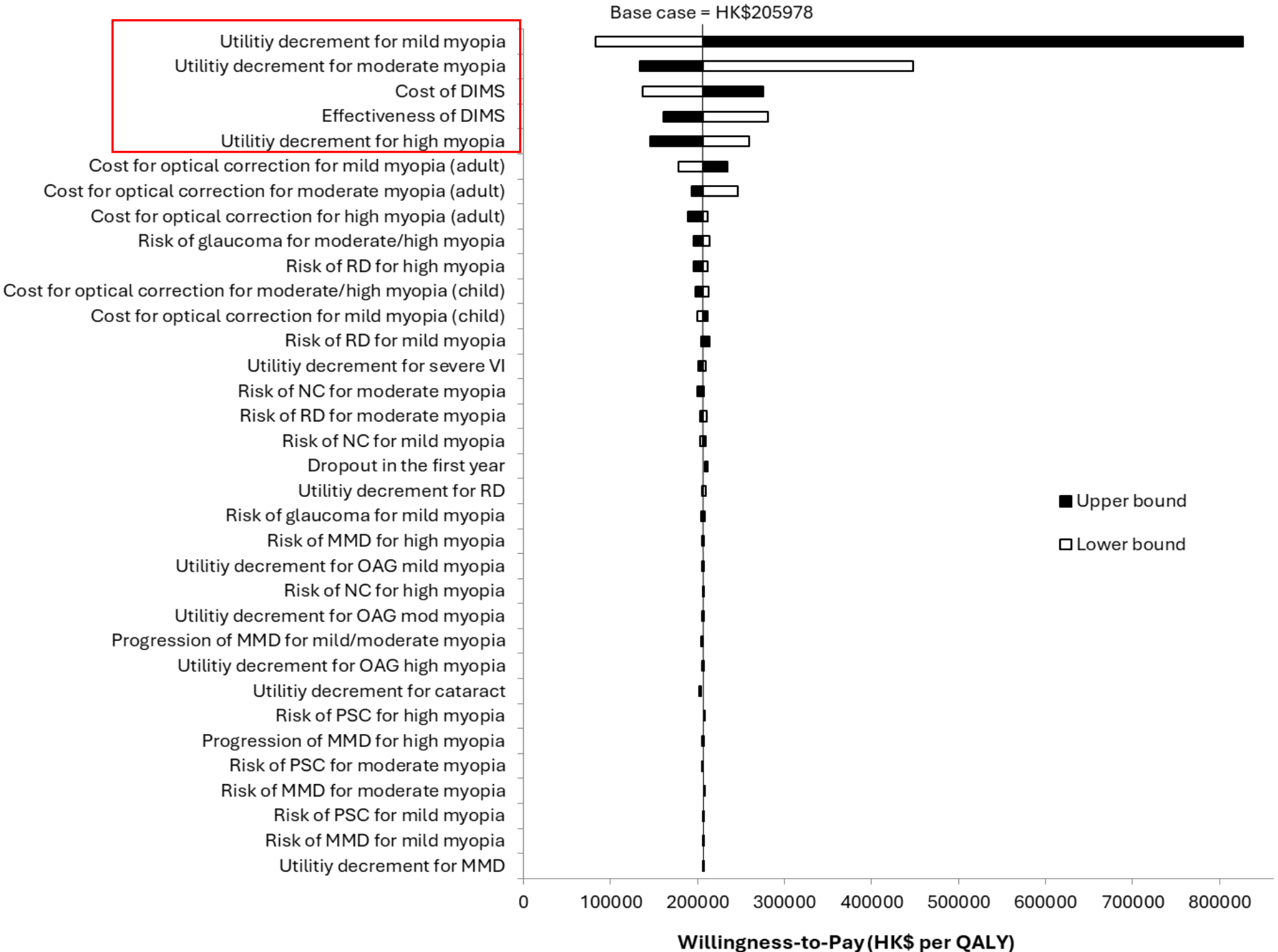
	Cost* (HK$)	Incremental cost (HK$)	QALYs*	QALYs gained	ICERs (HK$)‡
Base case – Discount at 3.5% on both costs and QALYs					
No myopia control (0% uptake)	47298		25.84		
With myopia control (100% uptake)	57387	10089	25.89	0.05	205978

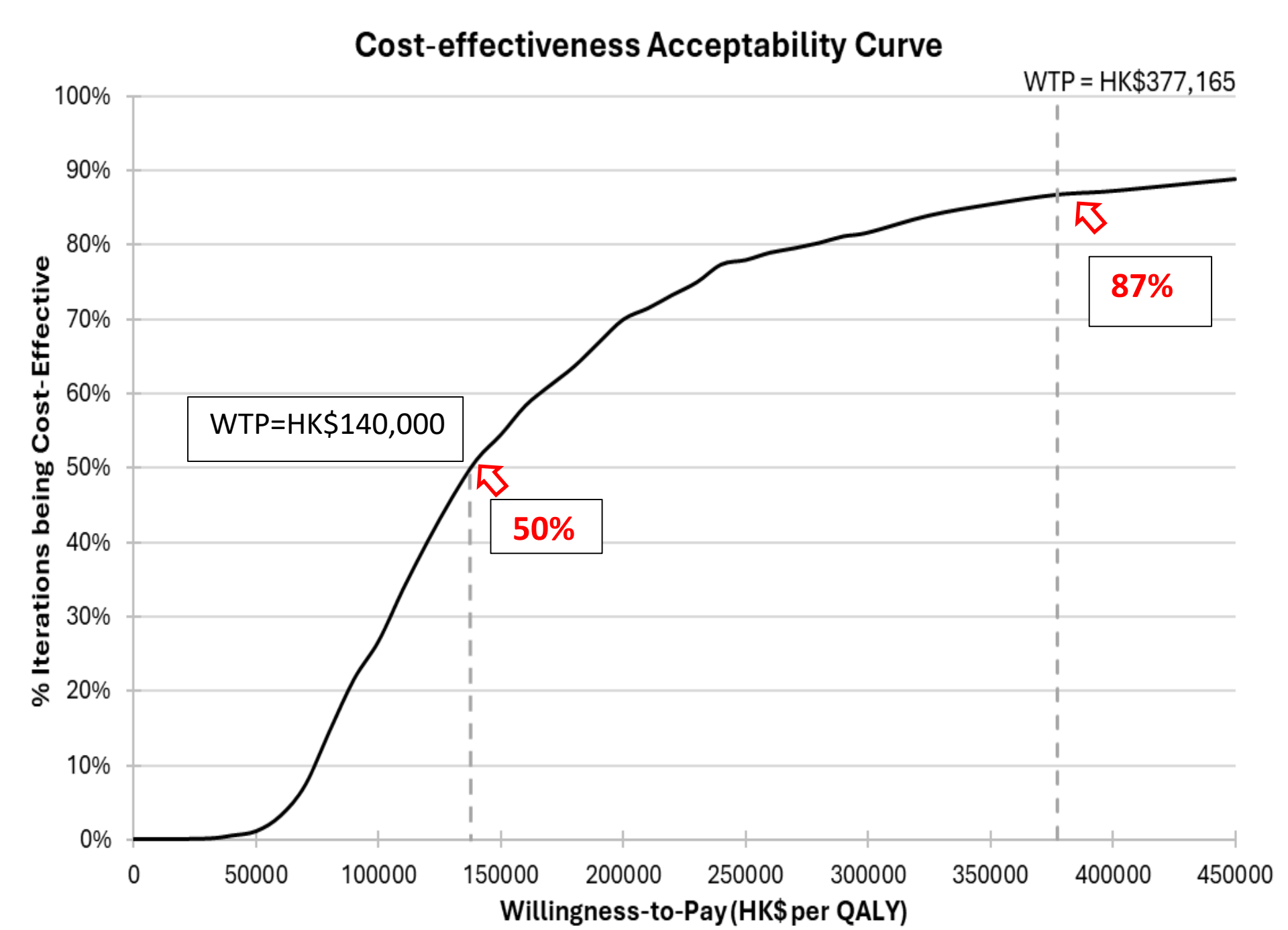
* Average value per individual across lifetime

‡ May not exactly equal to the costs divided by QALYs, due to rounding of the decimals

- Incremental cost per extra QALY gained
- < World Health Organisation (WHO) threshold of one GDP per capita (**HK$377,165** in 2019)

Tornado chart for one-way sensitiviy analyses




Cost-effectiveness Acceptability Curve
WTP = HK$377,165
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Iterations being Cost-Effective
WTP=HK$140,000
50%
87%
0
50000
100000
150000
200000
250000
300000
350000
400000
450000
Willingness-to-Pay (HK$ per QALY)

Results

Part 2. If it is value for money, would it be cost-effective to subsidise myopia control for children from the government perspective?

Table 3: Long-term costs and consequences of myopia control with and without subsidy from the government perspective

	Cost* (HK$)	Incremental cost (HK$)	QALYs*	QALYs gained	ICERs (HK$)‡
Base case – Discount at 3.5% on both costs and QALYs					
No subsidy (10% uptake)	2971		25.85		
Full subsidy (80% uptake)	11638	8668	25.88	0.04	232049

* Average value per individual across lifetime

‡ May not exactly equal to the costs divided by QALYs, due to rounding of the decimals

Discussion

- First cost-effectiveness model in the literature:
  - comprehensive evaluation across life-time
  - good validation

Benefit

Prevention of
high myopia/
related ocular complications/
severe visual impairment

In the future

future savings in
direct health services utilization for ocular complications/
productivity loss /
patients' cost

The WHO threshold for a highly cost-effective procedure

= 1 x annual per capita GDP

= **HK$377,165** per QALY (in 2019)

- **Myopia control using DIMS vs** no myopia control: highly cost-effective from the societal perspective providing to all eligible children aged 6-11.
  - ICER=**HK$205,978**/QALY
  - even considering the uncertainties around the parameters

- **Full subsidy on myopia control vs** no subsidy: highly cost-effective from government perspective providing to all eligible children aged 6-11

  - ICER=HK$**232,049**/QALY
  - Less than WHO threshold of 1 GDP per capita

Limitation: some of the data incorporated into the model was not available in HK, e.g. utility decrement values, transition probabilities, uptake rate of myopia control with subsidy

Implication

- A strategic plan for myopia control is undoubtedly needed to reduce the disease and economic burden of myopia-related complications and vision loss.

- Providing economic evidence for decision-makers to address the increasing public health problem and equity issues in accessing myopia control.

Conclusion

- Myopia control by use of DIMS lenses is potentially cost-effective for society. A government-subsidised programme could be a cost-effective option to improve equity of access.

Publication

- So C, Lian J, McGhee SM, Sum RWM, Lam AKC, Yap MKH. Lifetime cost-effectiveness of myopia control intervention for the children population. *Journal of global health* 2024;14:04183. doi: 10.7189/jogh.14.04183

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Thank you