



ECONOMIC IMPACT AND COST OF HEARING LOSS IN SINGAPORE

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OBJECTIVE OF THIS STUDY

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- Estimate economic impact and **cost** of hearing loss in **Singapore** for year **2013**

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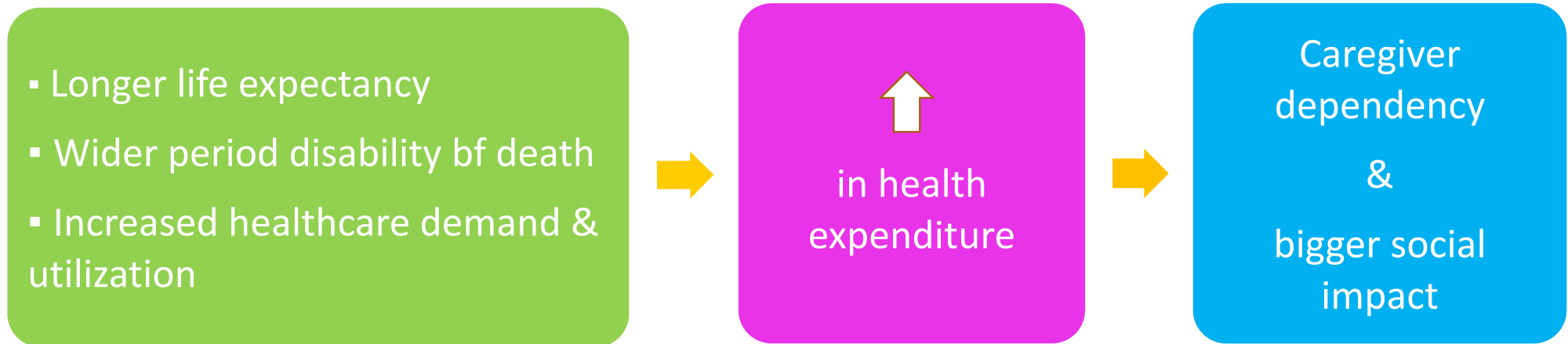
- **Project** the estimated cost and economic impact for **2030**

WHY IS THIS STUDY IMPORTANT?

- **1st** cause disability worldwide ➡ Adult onset hearing loss (GBD, 2004)

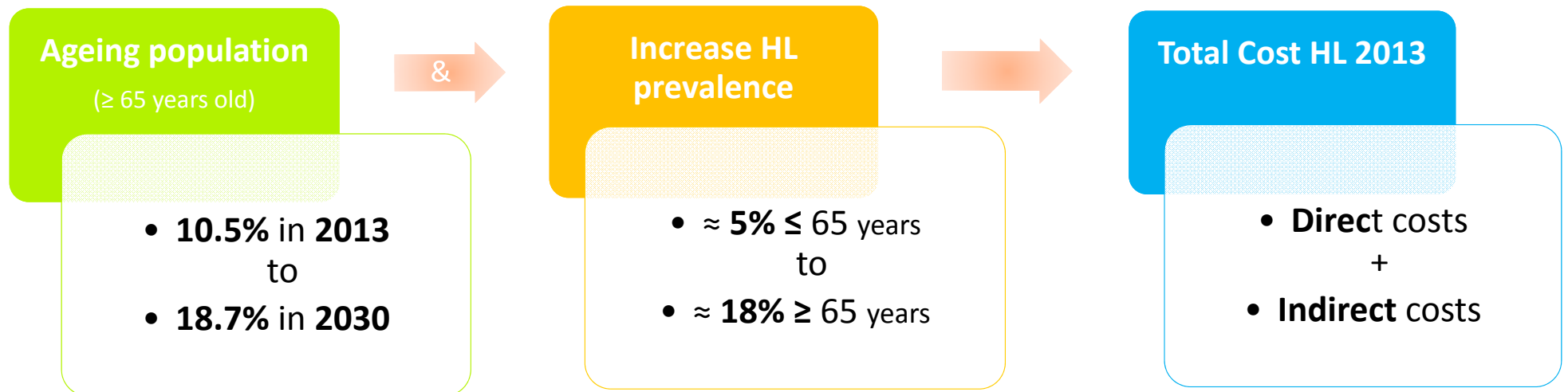
In Singapore:

- Adult onset hearing loss ➡ **top 10** disabilities elderly population (SBD, 2004)



WHY IS THIS STUDY IMPORTANT?

- The problem:

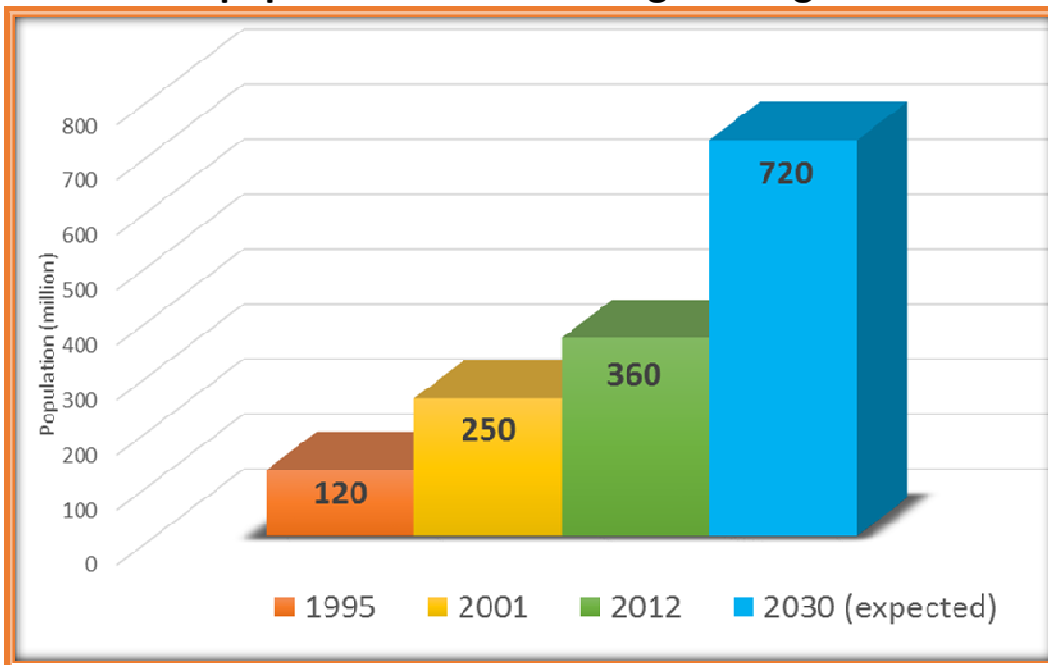


- “How much does hearing loss cost the Singaporean society? How much will it cost in the future?”

PREVALENCE OF HEARING IMPAIRMENT

- Hearing loss is the **most prevalent** impairment worldwide

Worldwide population with Disabling Hearing Loss (WHO, 2012)



- **Disabling** hearing impairment:
HL $\geq$ 41 dB HL in better ear (WHO)
- **Overall HI: > 25 dB BEHL**

PREVALENCE OF HEARING IMPAIRMENT

Country	Overall HL (>25 dB HL)		Disabling HL (≥41 dB HL)		
	Children (0-14yrs)	Adults (≥15 yrs)	Children (0-14 yrs)	Adults (≥15)	Senior (≥65)
U.S.	0.31%	12.7%	0.1%	-	-
Europe	-	16.5%	0.11% - 0.21%	5.5%	-
Australia	0.25%	16%	0.12% – 0.32%	2.1%	-
Singapore	0.37%	14.5%	-	2.9%	-
WHO	-	15%	0.5%	5%	18%

- **Overall HL** prevalence in Singapore **similar** to other comparable High-Income countries and WHO
- **Disabling HL** prevalence in Singapore **lower** than Europe & WHO – limitations of prevalence study

- HPB conducts community screening for elderly
- Hearing screening included
- Prevalence of HL Singaporeans ≥ 65 ≈ **87%**
- Not used in this study – protocol not well defined
- Rate seems possible, but very ≠ WHO

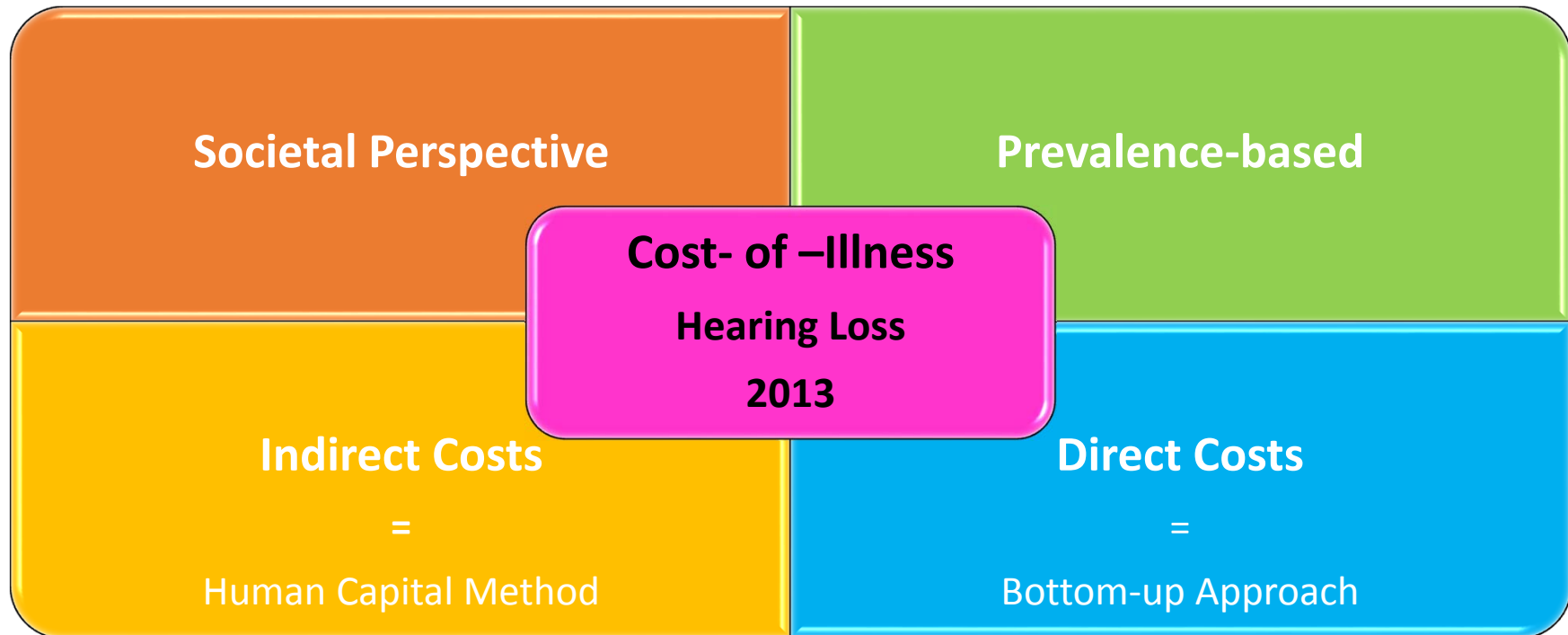
Prevalence of HI in Singapore elderly population (HPB, 2013)			
Age (years)	Nº people	Nº people HI	% of HI (> 40 dB at least one ear)
65 – 74	1423	1194	84 %
75 – 85	583	542	93 %
86 – 95	82	77	94 %
Age	Total nº people	Total nº people HI	Overall prevalence HI
≥ 65	2088	1813	87%

PREVIOUS STUDIES

- Only a few studies evaluating costs of hearing loss worldwide
- None in Singapore

Country	Cost HL / Year (S\$)	Cost HL / Person / Year (S\$)
Europe	Social and economic costs of hearing impairment in Europe (Shield, 2006)	
	S\$ 616.3 billion	S\$ 8 613.00
Australia	Economic impact and cost of hearing loss in Australia (Access Economics, 2006)	
	S\$ 14.71 billion	S\$ 4 149.00
Country	Cost Severe – Profound HL / Person / Lifetime (S\$)	
U.S.	Societal costs severe to profound hearing loss in the U.S. (Mohr <i>et al</i> , 2000)	
	S\$ 501 676.00	
Country	Study approach towards evaluation of costs of HL	
U.S.	Monetary approach, incidence-based, severe to profound HL only	
Europe	QOL approach (monetary + psychological costs), prevalence-based, HL>25 dB BEHL	
Australia	Financial approach, prevalence-based, HL>25 dB BEHL	
Singapore	Financial approach, prevalence-based, HL>25 dB BEHL	

METHODOLOGY



Discount Rate = Positive time preference – inflation – productivity growth

$$\text{DR} = 5.3 - 2.47 - 2 = \mathbf{0.83\%}$$

METHODOLOGY

Non-Economic Data Collection

- HI Prevalence rate derived from NHS 2010
- Demographic information from Population Trends 2013

Direct Costs components:

- ENT & GP consultations related to HL
 - Full range Audiological tests
 - Hearing Aids
 - Cochlear & Implants
 - Auditory rehabilitation
 - Consumables for devices
- Diagnostic
- Rehabilitation

Data sourced from:

- Restructured Hospitals
- Private HA and CI manufacturers and distributors

Indirect Costs components:

- Productivity losses
- Taxation revenue foregone

Data sourced from:

- MOM
- IRAS
- Literature review

Intangible Costs

- Not included in this study

RESULTS

Prevalence Hearing Impairment Singapore

2013 = 4.1% DHI

SINGAPORE RESIDENT POPULATION 2013 = 3,844.800 million						
Age Range	% Population	Population (thousand)	Overall HI Prevalence rate	Population Overall HI 2013	DHI Prevalence rate	Population DIH 2013
≤14 yrs	16.0%	615,200	-	-	0.5%	3,076
15 – 64 yrs	73.5%	2,825.200	14.5%	468,292	2.9%	81,931
≥65 yrs	10.5%	404,400			18%	72,792
Total population with DHI in 2013 (including children)						157,799

SINGAPORE PROJECTED RESIDENT POPULATION 2030 = 4,560.000 million						
Age Range	% Population	Population (thousand)	Overall HI Prevalence rate	Population Overall HI 2030	DHI Prevalence rate	Population DIH 2030
≤14 yrs	14.7%	669,600	-	-	0.5%	3,348
15 – 64 yrs	65.1%	2,967.300	14.5%	564,239	2.9%	86,052
≥65 yrs	20.2%	924,000			18%	166,320
Total population with DHI in 2030 (including children)						255,720

2030 = 5.6% DHI

↑ 62% DHI

RESULTS

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Direct Costs - Diagnostic

SUBSIDIZED PATIENTS (≈ 28 000 IN 2013)					PRIVATE PATIENTS (≈ 7 000 IN 2013)				
Diagnostic Procedures	Average \$ Procedure	Nº Procedures (%)	Nº procedures 2013	Total cost/procedure 2013 (\$ SGD)	Diagnostic Procedures	Average \$ Procedure	Nº Procedures (%)	Nº procedures 2013	Total cost/procedure 2013 (\$ SGD)
GP consultation	\$ 30.00	100.00	28 000	\$ 840 000.00	ENT consultation	\$ 87.00	100.00	7 000	\$ 609 000.00
ENT consultation	\$ 38.50	100.00	28 000	\$ 1 078 000.00	Pure Tone Audiogram	\$ 25.00	100.00	7 000	\$ 175 000.00
Pure Tone Audiogram	\$ 10.50	100.00	28 000	\$ 294 000.00	Tympanogram	\$ 18.70	69.00	4 830	\$ 90 321.00
Tympanogram	\$ 7.80	66.00	18 480	\$ 144 144.00	Hearing Aid Evaluation	\$ 50.00	8.00	560	\$ 28 000.00
Hearing Aid Evaluation	\$ 26.50	11.00	3 080	\$ 81 620.00	Other tests	\$ 151.00	7.00	490	\$ 73 990.00
Other tests	\$ 59.00	7.00	1 960	\$ 115 640.00	TOTAL COST	S\$ 331.70			S\$ 976 311.00
TOTAL COST	S\$ 172.30			S\$ 2 553 404.00					

Diagnostic Procedures	Total Cost 2013	Total nº patients 2013
	S\$ 3 529 715.00	35 000
Average cost/patient	S\$ 100.85	

RESULTS

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Direct Costs - Rehabilitation

COSTS ASSOCIATED WITH HEARING AIDS			
Devices/services	Average Cost/year	Average Cost Maintenance/year	Nº HA's 2013
Hearing Aid	\$ 2 170.00	\$ 0.00	7 100
Follow-up consultation	\$ 25.00	\$ 25.00	
Batteries (50 units)	\$ 67.50	\$ 67.50	
Maintenance	\$ 150.00	\$ 150.00	
Average cost HA/unit	\$ 2 412.50	\$ 242.50	
TOTAL COST HA's 2013	\$ 17 128 750.00		

COSTS ASSOCIATED WITH COCHLEAR IMPLANTS			
Devices/services	Average Cost (\$) 1 st Year	Average Cost (\$) Maintenance/year	Nº CI's 2013
CI including surgery	\$ 50 000.00	\$ 0.00	60
Mapping sessions	\$ 152.50	\$ 30.50	
Maintenance	\$ 500.00	\$ 500.00	
Average cost CI/unit	\$ 50 652.50	\$ 530.50	
TOTAL COST CI's 2013	\$ 3 039 150.00		

TOTAL COST REHABILITATION HA's & CI's 2013

\$ 20 167 900.00

RESULTS

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Direct Costs Summary

HI DIRECT COSTS 2013			
	Aver cost/patient	Nº patients/devices	Total Cost 2013
Diagnostic	S\$ 100.85	35 000 pts	S\$ 3 529 750.00
Rehab. HA's	S\$ 2 412.50	7 100 units	S\$ 17 128 750.00
Rehab CI's	S\$ 50 652.50	60 units	S\$ 3 039 150.00
TOTAL DIRECT COSTS 2013 (35 000 HI individuals)			S\$ 23 697 650.00

Population with HI 2013		468 292	
HA Adoption Rate (%)	Nº Adults HA 2013	Binaural Rate (%)	Nº HA's 2013
14%	65 560	38%	90 473
% Sev/Prof HI	Nº Sev/Prof HI 2013	% CI's	Nº CI's 2013
11%	51 512	1.56%	802

Degree HL	Mild	Moderate	Sev / Prof
%	66%	23%	11%

RESULTS

Total Direct Costs 2013

TOTAL DIRECT COSTS FOR HI POPULATION 2013			
	Aver cost per patient	Nº pts/devices	Total Cost 2013
Diagnostic	S\$ 100.85	468 292 pts	S\$ 47 227 248.20
Rehab. HA's	S\$ 676.50	90 473 units	S\$ 61 204 984.50
Rehab CI's	S\$ 4 652.50	802 units	S\$ 3 731 305.00
TOTAL DIRECT COSTS 2013			S\$ 112 163 537.70

RESULTS

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Indirect Costs – Productivity Losses

Estimations cost unemployment due to HI in 2013	
Working age population was considered between 15 to 64 years old	
Total n° people of working age with HI (>25 dB BEHL)	409 654
Proportion of people with HL in employment	65%
Estimate n° people employed with HI	266 275
Employment rate for those without HI	70%
Estimate n° people employed without HI	286 758
Estimated n° people unemployed due to HI	20 483
Average annual income 2013	S\$ 48 165.00
Cost of unemployment due to HI in 2013	S\$ 986 563 695.00

- No info in Singapore
- Average **employment rate** in Singapore = **70%**
- **Unemployment rate due to HI = 5%**
- Cost = **0.33% GDP**

Employment rate by degree of HI (%)		
	Any ° HI	No HI
O'Neill (1999)	67%	75%
Mohr et al., (2000)	-	74%
Ruben (2001)	63.4%	74.8%
Aver Empl. Rate	≈ 65%	≈ 75%
Additional Unemployment Rate caused by HI		10%

RESULTS

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Indirect Costs – Taxation Revenue Foregone

Tax collection is affected by:

- **Foregone Personal Income Taxation**
- Decrease in consumption tax (GST)
- Affects individual and family & Government

YEAR 2013	Earnings	Deductions	Tax Payable
Avr Annual Income	S\$ 48 165.00		
Earned Income Relief		S\$ 1 000.00	
Chargeable Income	S\$ 47 165.00		S\$ 1 051.55
Personal Income Tax Rebate (30%)		S\$ 315.46	
Total Tax Payable			S\$ 736.09

ESTIMATED TAXATION REVENUE FOREGONE 2013	
Personal Income Tax 2013 ($\approx 1.53\%$)	S\$ 736.09
Nº unemployed due to HI (>25 dB BEHL)	20 483
Total Tax Revenue Foregone 2013	$\approx$ S\$ 15 077 332.00

RESULTS

Total Indirect Costs

ESTIMATED INDIRECT COSTS FOR HI POPULATION 2013	
Working age population considered between 15 to 64 years old	
Total n° people working age with HI	409 654
Unemployment rate for HI population	5%
Estimated n° HI people unemployed	20 483
Average annual income in 2013	S\$ 48 165.00
Personal Income Tax 2013 (≈1.53%)	S\$ 736.09
Productivity losses due to HI in 2013	S\$ 986 563 695.00
Total Tax Revenue Foregone 2013	S\$ 15 077 332.00
TOTAL INDIRECT COSTS HI 2013	S\$ 1 001 641 027.00

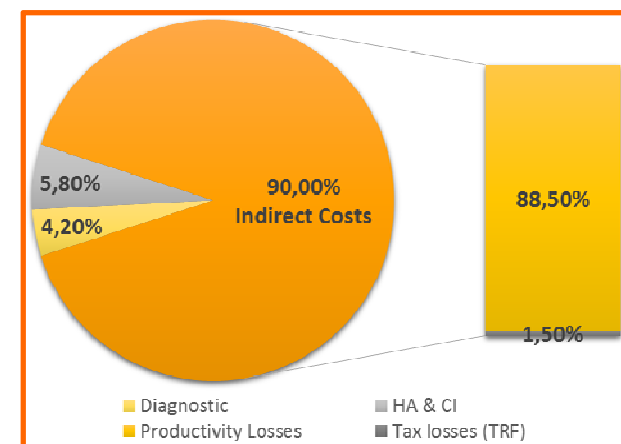
RESULTS

Total Cost Hearing Impairment 2013

TOTAL FINANCIAL COST SUMMARY 2013	
Total Direct Costs	S\$ 112 163 537.70
Diagnostic Costs	S\$ 47 227 248.20
Rehabilitation Costs with HA's	S\$ 61 204 984.50
Rehabilitation Costs with CI's	S\$ 3 731 305.00
Total Indirect Costs	S\$ 1 001 641 027.00
Productivity Loss	S\$ 986 563 695.00
Taxation Revenue Foregone	S\$ 15 077 332.00
TOTAL COST HI 2013	S\$ 1 113 804 564.70
Cost per person with HI	≈ S\$ 2 378.00
Cost per capita (population)	≈ S\$ 290.00
% of GDP	0.37%



S\$ 1.113 billion



RESULTS

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Direct Costs Projections 2030

Population with HI 2030		564 239	
HA Adoption Rate (%)	Nº Adults HA 2030	Binaural Rate (%)	Nº HA's 2030
25%	141 060	65%	232 749
% Sev/Prof HI	Nº Sev/Prof HI 2030	% CI's	Nº CI's 2030
11%	62 066	3%	1 862

TOTAL DIRECT COSTS FOR HI POPULATION 2030			
	Average cost/ patient	Nº patients/devices	Total Cost 2030
Diagnostic	S\$ 132.98	564 239 pts	S\$ 75 032 502.00
Rehab. HA's	S\$ 892.00	232 749 units	S\$ 207 612 108.00
Rehab CI's	S\$ 6 134.59	1 862 units	S\$ 11 422 607.00
Total Direct Costs 2030			S\$ 294 067 217.00

RESULTS

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Indirect Costs Projections 2030

ESTIMATIONS COST UNEMPLOYMENT DUE TO HI IN 2030	
Working age population was considered between 15 to 64 years old	
Total nº people of working age with HI (≥ 25 dB BEHL)	430 259
Proportion of people with HL in employment	65%
Estimate nº people employed with HI	279 668
Employment rate for those without HI	70%
Estimate nº people employed without HI	301 181
Estimated nº people unemployed due to HI	21 513
Average annual income 2030	S\$63 508.00
Cost of unemployment due to HI in 2030	S\$ 1 366 247 604.00

ESTIMATED TAXATION REVENUE FOREGONE 2030	
Personal Income Tax 2030 ($\approx 3.35\%$)	S\$ 2 125.69
Nº unemployed due to HI (≥ 25 dB BEHL)	21 513
Total Tax Revenue Foregone 2030	$\approx$ S\$ 45 729 971.00

TOTAL INDIRECT COSTS 2030	$\approx$ S\$ 1 411 977 575.00
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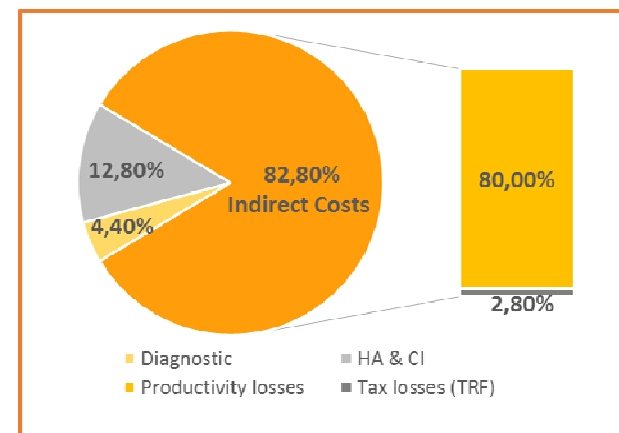
RESULTS

Total Cost HI Projections 2030

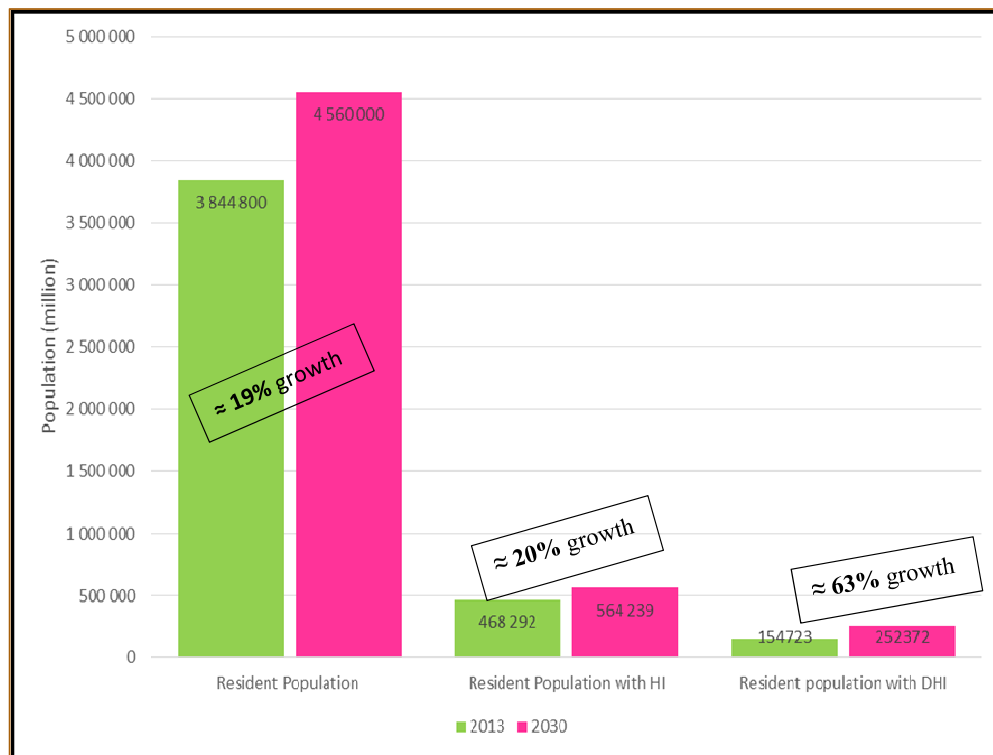
TOTAL FINANCIAL COST SUMMARY	
Total Direct Costs 2030	S\$ 294 067 217.00
Diagnostic Costs	S\$ 75 032 502.00
Rehabilitation Costs with HA's	S\$ 207 612 108.00
Rehabilitation Costs with CI's	S\$ 11 422 607.00
Total Indirect Costs 2030	S\$ 1 411 977 575.00
Productivity Loss	S\$ 1 366 247 604.00
Taxation Revenue Foregone	S\$ 45 729 971.00
TOTAL COST HI 2030	S\$ 1 706 044 792.00
Cost per person with HI	≈ S\$ 3 024.00
Cost per capita (population)	≈ S\$ 374.00
% of GDP (forecasted S\$ 454 billion)	≈ 0.38%



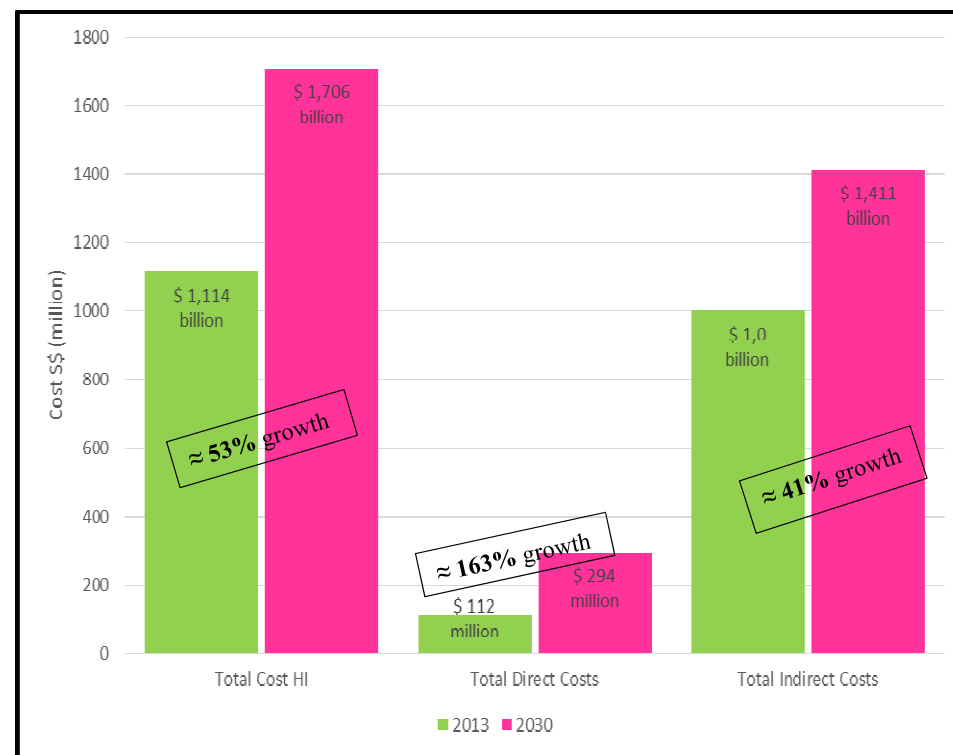
S\$ 1.7 billion



RESULTS



Projected growth of Resident population, Resident HI population and Resident DHI population



Projected growth of HI costs in Singapore resident population

DISCUSSION

Comparison with previous studies

Country	Year	Cost HL/Year (Country currency)	Cost HL/Year (S\$)
Singapore	2013	S\$ 1.114 billion	
Europe	2004	€ 284 billion	S\$ 616.3 billion
Australia	2005	A\$ 11.75 billion	S\$ 14.7 billion
Country	Year	Cost HL/Person/Year (S\$)	Cost HL per capita (S\$)
Singapore	2013	S\$ 2 378.00	S\$ 290.00
Europe	2004	S\$ 8 613.00	S\$ 1 369.40
Australia	2005	S\$ 4 149.00	S\$ 723.63
Country	Year	Cost Sev-Prof HL/Person/Lifetime (Country currency)	Cost Sev-Prof HL/Person/Lifetime (S\$)
U.S.	2000	\$297 000.00	S\$ 501 676.00

DISCUSSION

Study Limitations

- Limitations of study lead to **underestimation** of HI costs
- Direct costs estimation limited to standard **Audiological procedures**
- **Non-medical** costs (patients & family) not included, due to lack of information
- Costs associated with **education, support services** and **caregivers** not included (IC)
- **Employment** information for HI population not available
- Insufficient information to include **Paediatric** and **NIHL** populations
- HA's & CI's cost calculations based on **adoption** and **binaural rate** from Japan
- Productivity losses only included population between 15 – **64** years old
- **Monetary** approach, did not account for quality of life losses

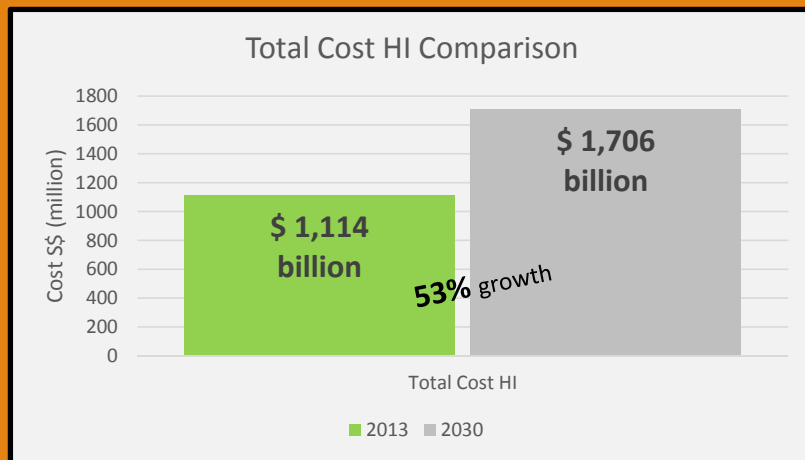
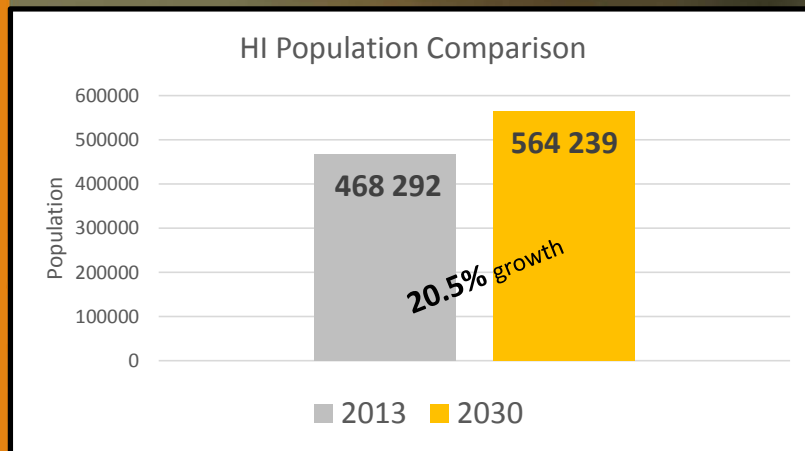
DISCUSSION

Future Research

- **Epidemiology of Hearing Loss:** National study to include all age groups
- **Epidemiology and prevention of NIHL**
- **Hearing Aids usage & satisfaction**
- **Productivity on HI population**
- **Cost of Education & Support services for HI population**



SUMMARY



- Cost is underestimated, but still significant
- Can't be compared to other High-Income countries. Several cost components not included in this study
- Gaps in information regarding HI in Singapore
- Future research suggested





**BETTER HEARING,
HAPPIER LIFE!!**

QUESTIONS?

THANK YOU!