

ICSN2023

CONCURRENT SESSION 3: INTEGRATING PRIMARY AND SECONDARY PREVENTION

Personalized Screening for Breast Cancer with Machine Learning Approach

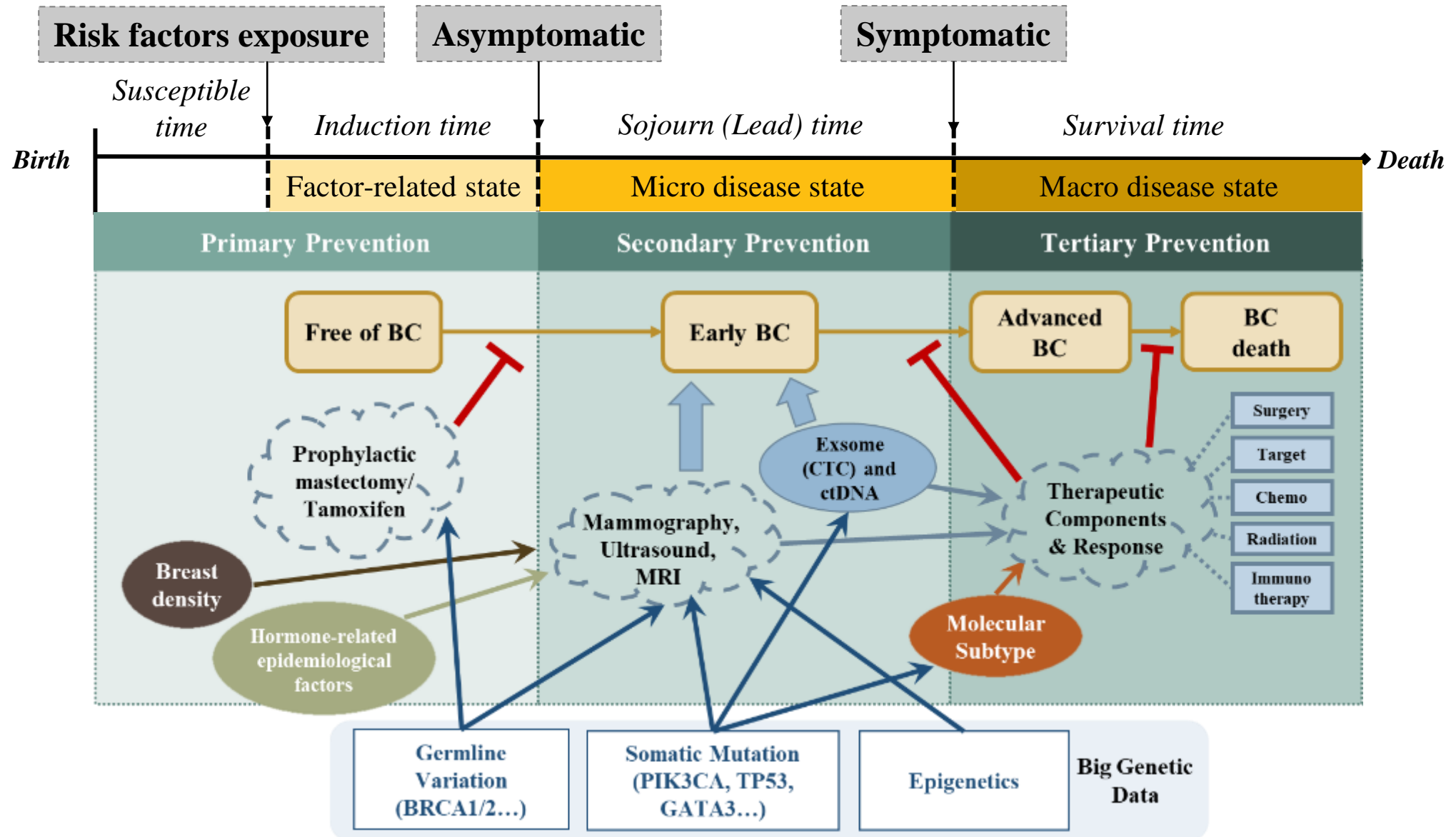
Grace Hsiao-Hsuan Jen

on behalf of Taiwan Breast Cancer Screening Team

2023.06.22



Precision Prevention, Surveillance, Treatment and Therapy for Breast Cancer



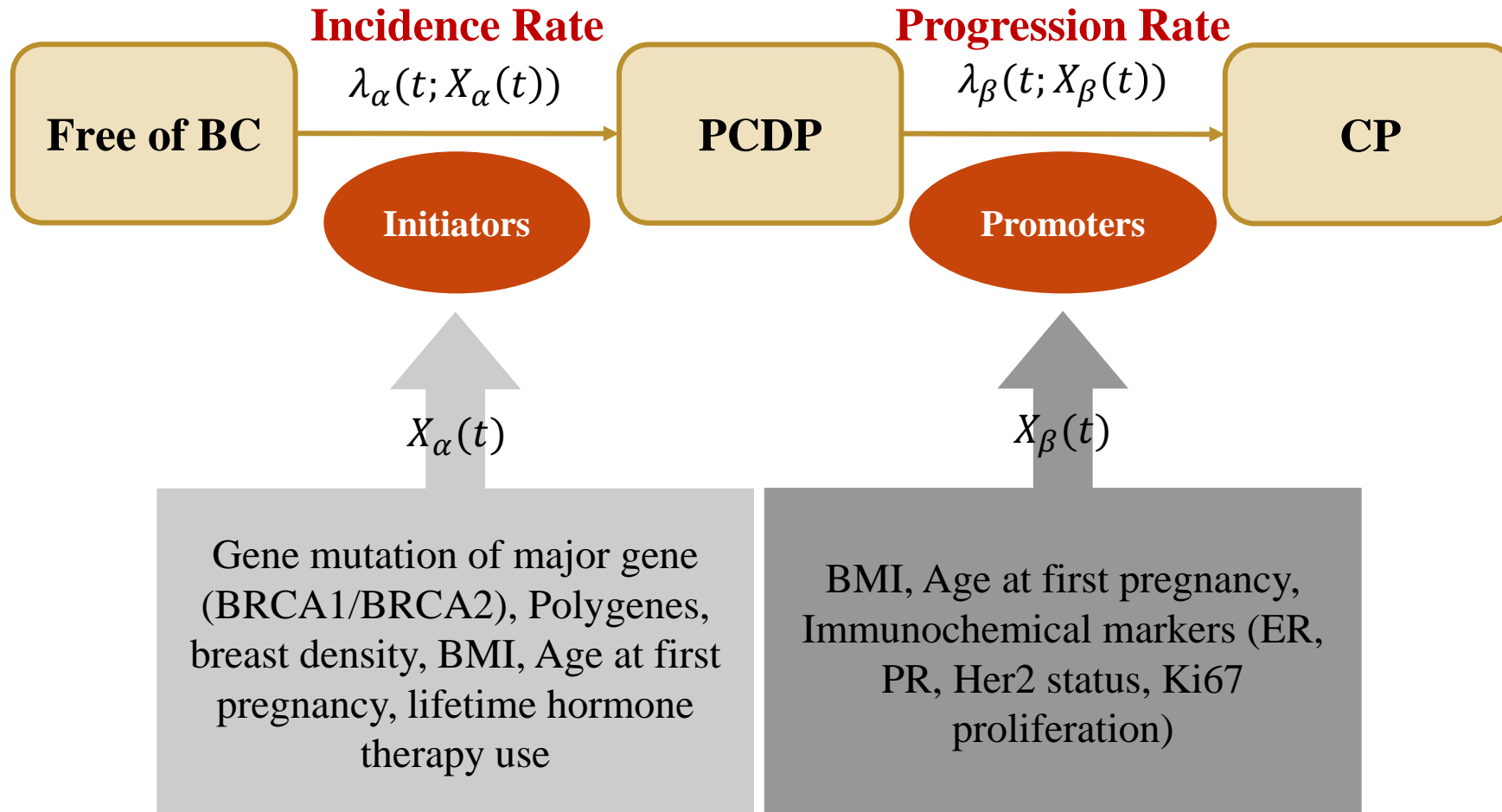
Study Aim

- 1) To develop a personalized screening strategy for breast cancer by using a deep machine learning approach.
- 2) To perform cost-effectiveness analysis of personalized screening strategy

Deep Machine Learning with Markov Algorithms to Develop Multi-state Risk Score

Multi-factor and Multi-state Dynamic Natural History Model

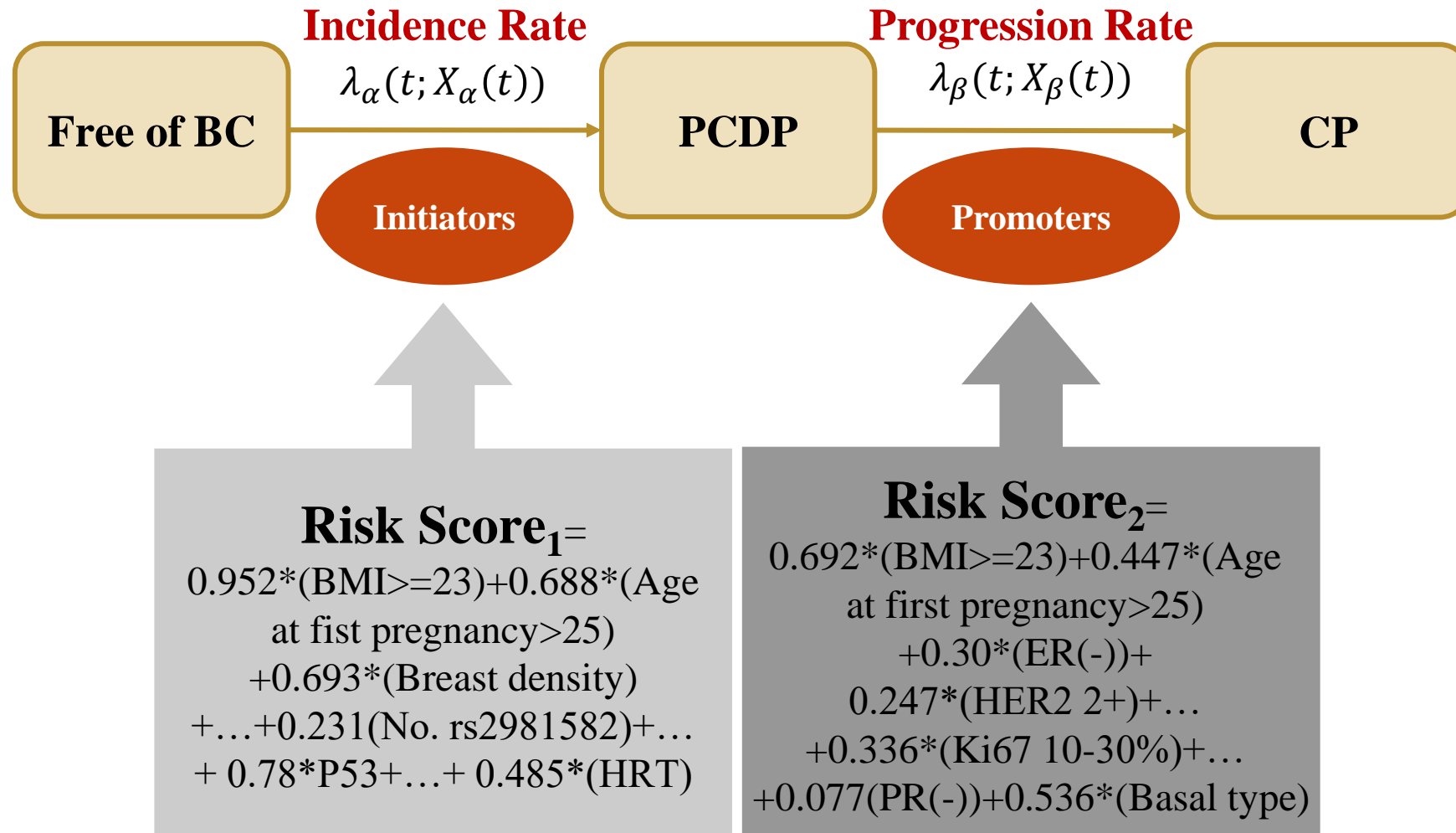
PCDP: preclinically detectable phase
CP: clinical phase



Deep Machine Learning with Markov Algorithms to Develop Multi-state Risk Score

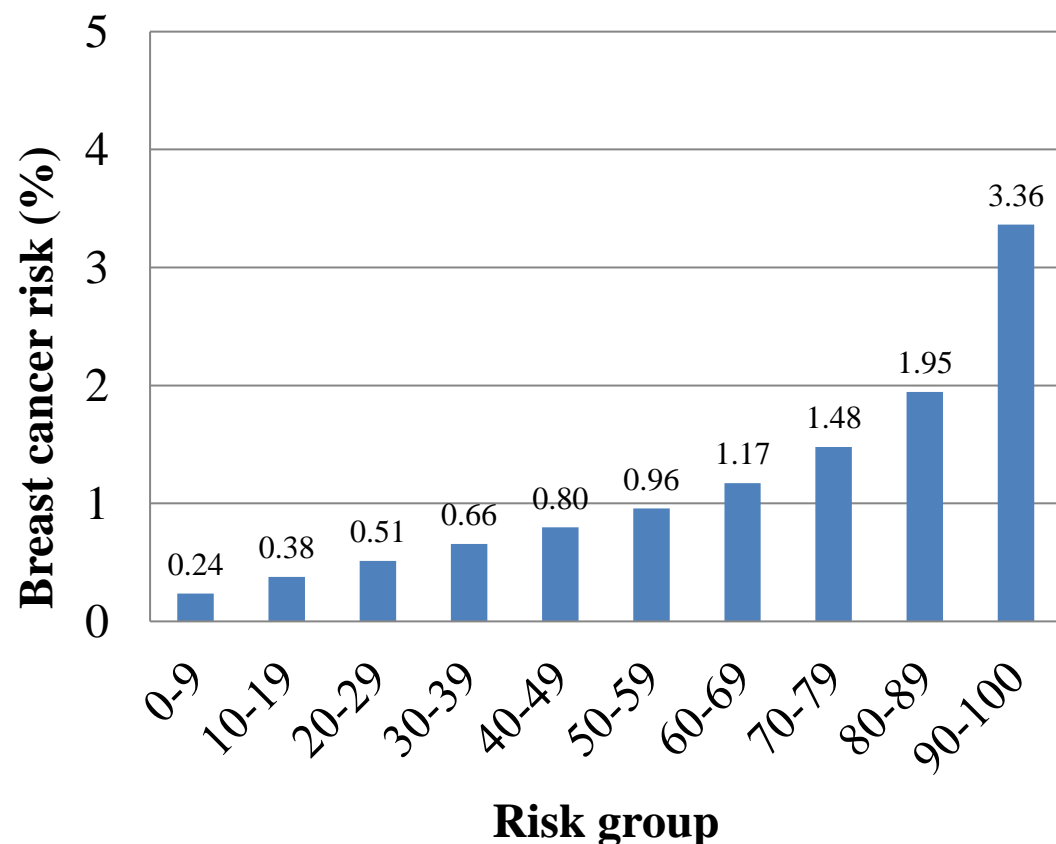
Multi-factor and Multi-state Dynamic Natural History Model

PCDP: preclinically detectable phase
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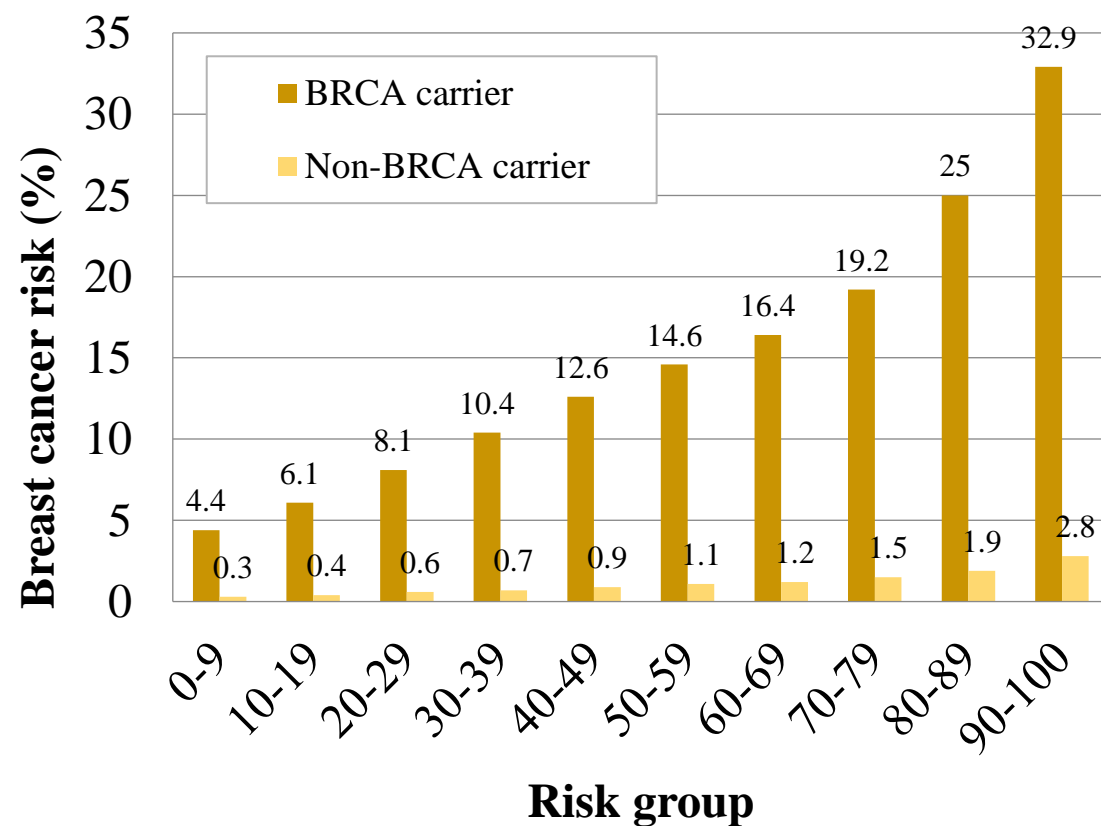


Ten-year risk of breast cancer for women at 50 years by risks

10-year risk

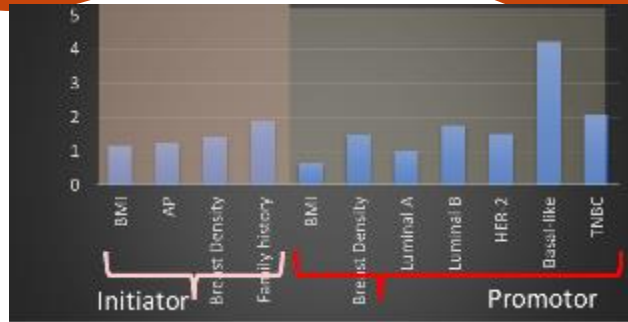


10-year risk by BRCA status



Deep Machine Learning with Markov Algorithms to Develop Multi-state Risk Score

PCDP: preclinically detectable phase
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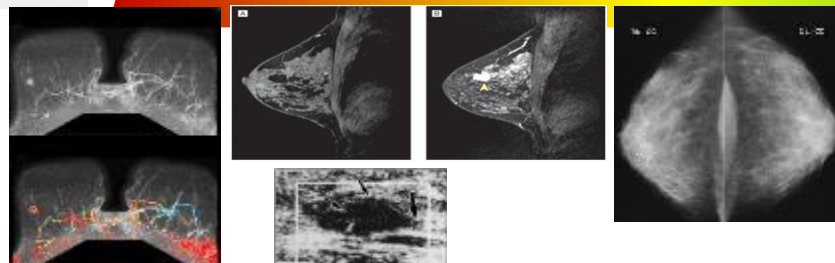
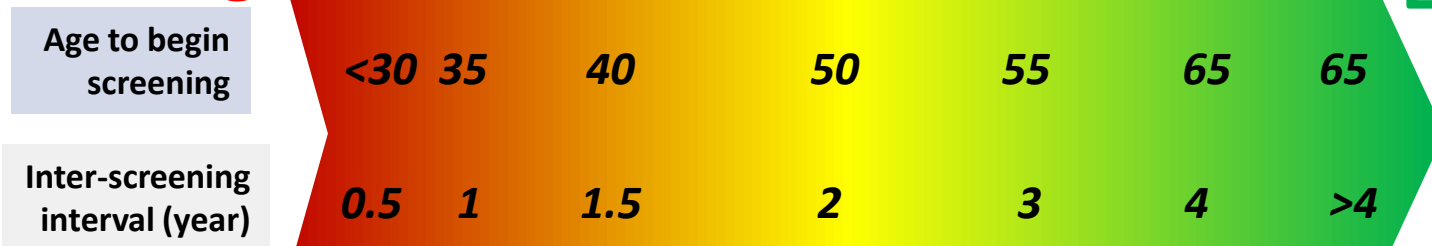


Subjects	BMI	Age at first full-term pregnancy	Breast density	Family history	Molecular subtype
A	≥25	>25	Dense	Yes	Basal-like subtype
B	<25	>25	Dense	No	HER-2+
C	<25	≤25	Non-dense	No	Luminal A

High

Personalized risk for breast cancer

Low

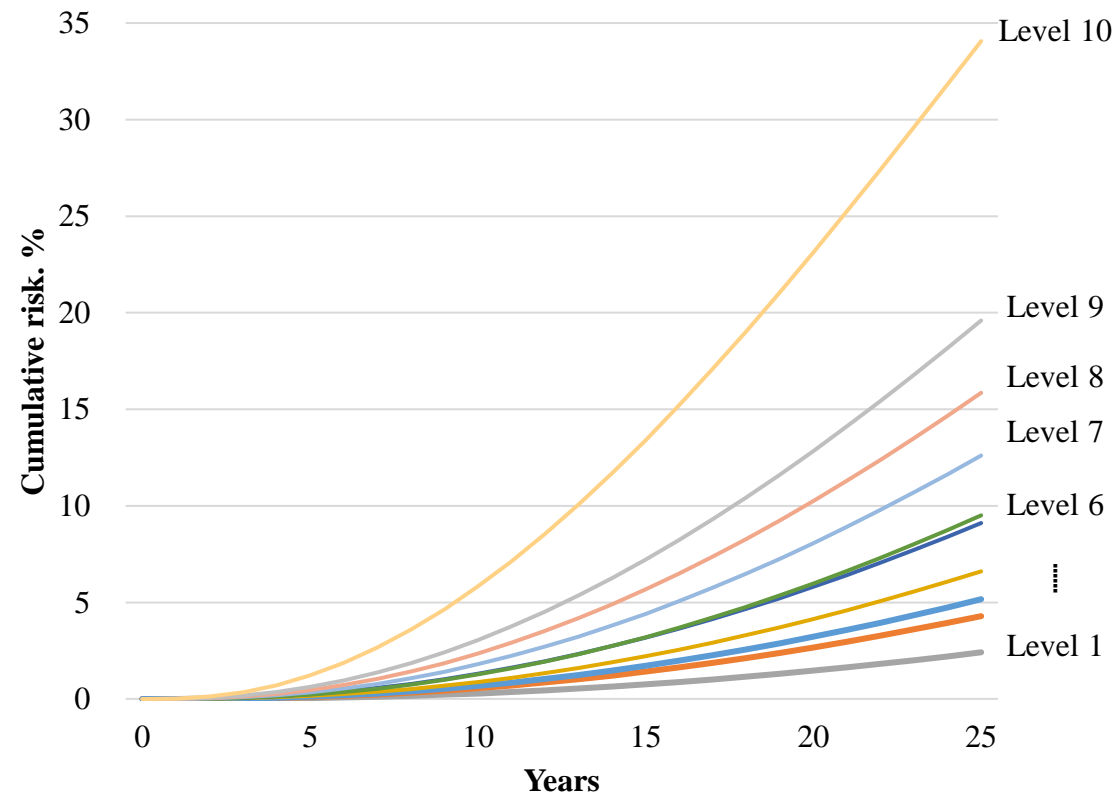


Individually tailored screening of breast cancer with genes, tumour phenotypes, clinical attributes, and conventional risk factors

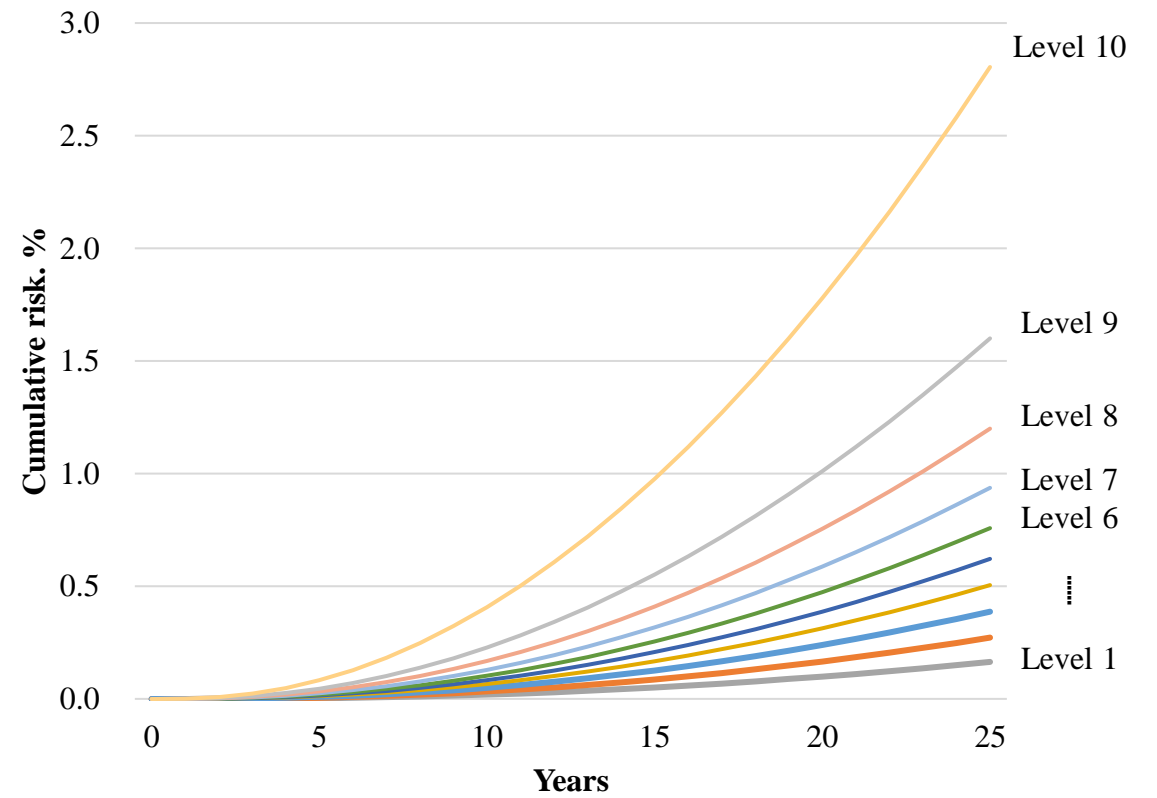
Y-Y Wu¹, M-F Yen², C-P Yu^{3,4} and H-H Chen^{5,1}

Dynamic risk of breast cancer by risks

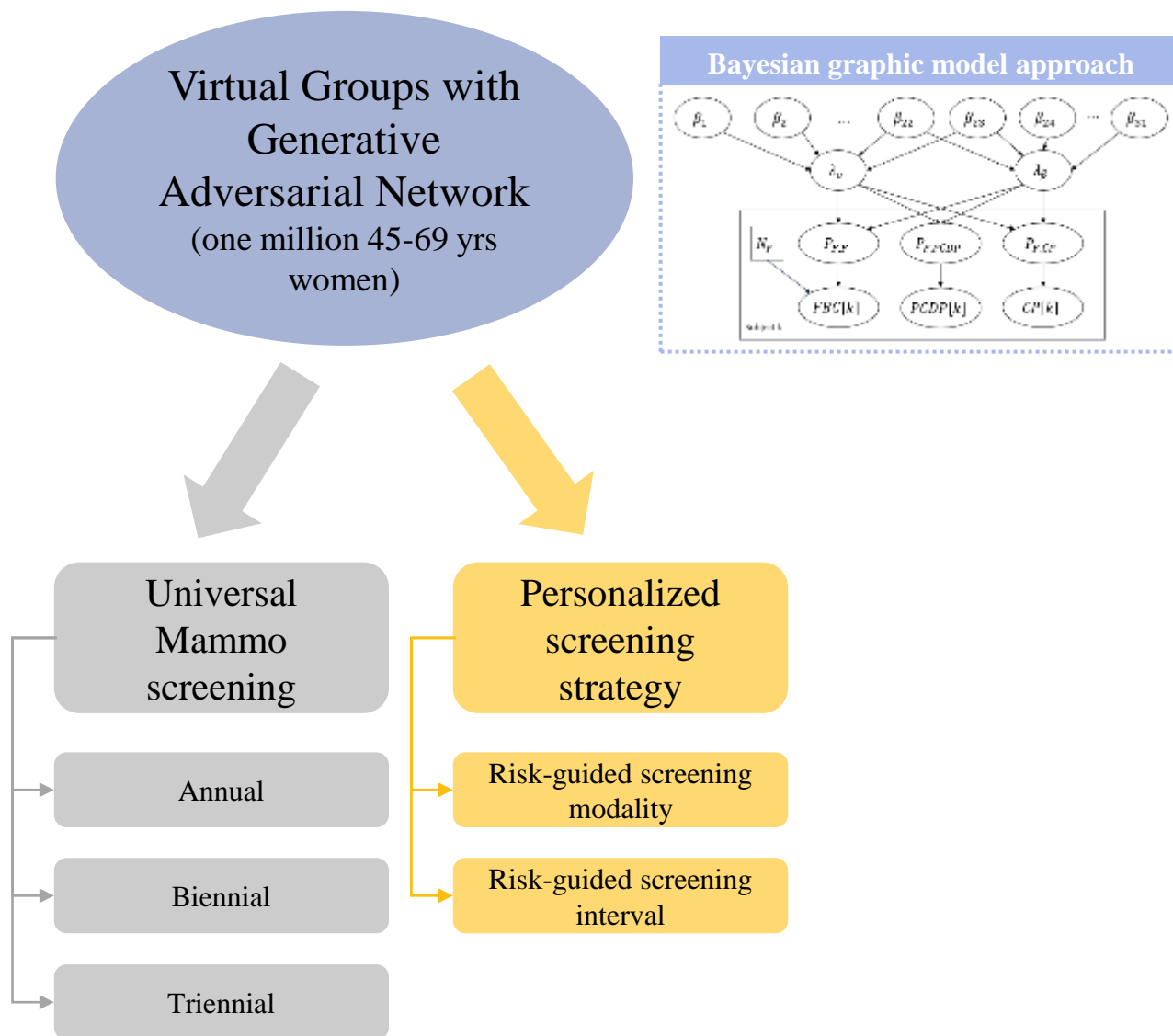
Cumulative risk for BRCA carriers



Cumulative risk for non-BRCA carriers



Bayesian DAG Machine Learning Method for Personalized Assessment



Risk stratification	Risk-guided screening modality		Risk-guided screening interval	
	Screening Interval (yrs)	Screening Modality	Screening Interval (yrs)	Screening Modality
Level 1 (0-9)	2	Mammo	6	Mammo
Level 2 (10-19)	2	Mammo	6	Mammo
Level 3 (20-29)	2	Mammo	4	Mammo
Level 4 (30-39)	2	Mammo	4	Mammo
Level 5 (40-49)	2	Mammo	2	Mammo
Level 6 (50-59)	2	Mammo	2	Mammo
Level 7 (60-69)	2	Sono+Mammo	1.5	Mammo
Level 8 (70-79)	2	Sono+Mammo	1	Mammo
Level 9 (80-89)	2	MRI+Sono+Mammo	1	Mammo
Level 10 (90-100)	2	MRI+Sono+Mammo	0.5	Mammo

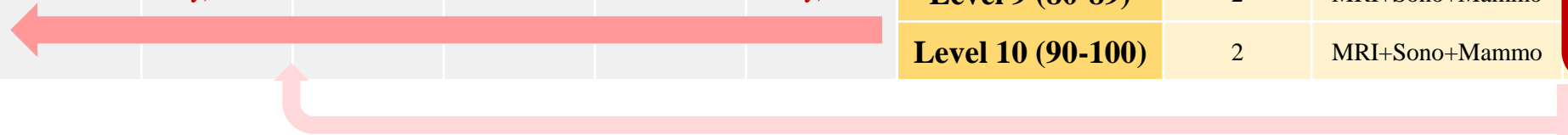
Mammo: mammography, Sono: sonography

Efficacy of Screening Strategies for Non-BRCA Carriers

Universal screening						Personalized screening				
Annual		Biennial		Triennial		Risk stratification	Risk-guided screening modality		Risk-guided screening interval	
Screening Interval (yrs)	Screening Modality	Screening Interval (yrs)	Screening Modality	Screening Interval (yrs)	Screening Modality		Screening Interval (yrs)	Screening Modality	Screening Interval (yrs)	Screening Modality
1	Mammo	2	Mammo	3	Mammo	Level 1 (0-9)	2	Mammo	6	Mammo
						Level 2 (10-19)	2	Mammo	6	Mammo
						Level 3 (20-29)	2	Mammo	4	Mammo
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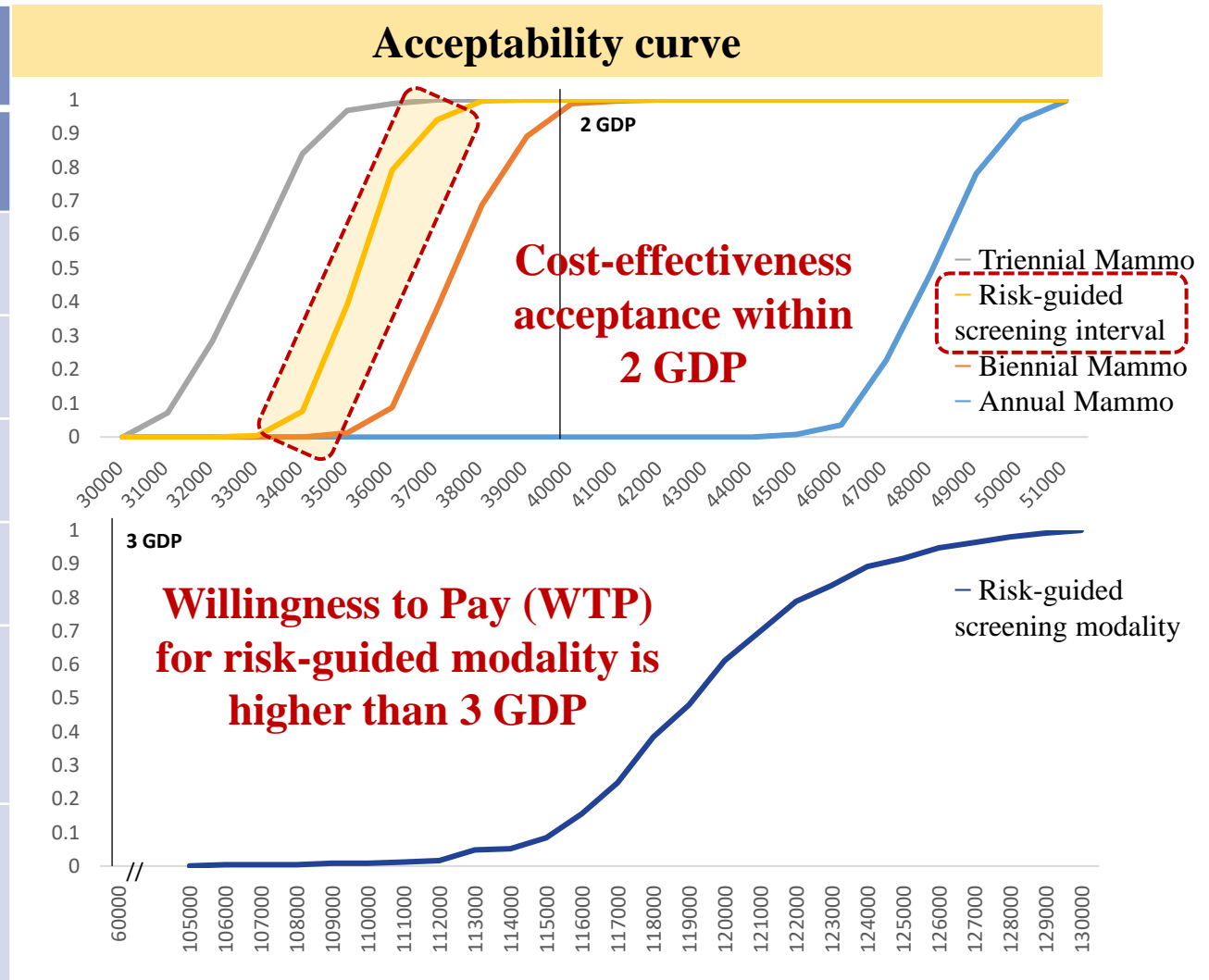
High Efficacy
(advanced BC/
Case-fatality)

Low Efficacy
(advanced BC/
Case-fatality)



Cost-effectiveness of Screening Strategies for Non-BRCA Carriers

Strategy	ICER
	Estimate (95% CI)
Non-screen	-
Annual	48,026 (47,871-48,181)
Biennial	37,473 (37,331-37,615)
Triennial	32,805 (32,653-32,958)
Risk-guided screening interval	35,278 (35,155-35,401)
Risk-guided screening modality	119,315 (118,850-119,780)



Conclusions

- This study has successfully developed a personalized screening strategy for breast cancer that incorporates multiple risk scores reflecting different stages of disease progression and demonstrates that the risk-based screening interval strategy is not only effective but also cost-effective.
- This machine learning approach allows us to simulate various combinations of personalized screening strategies, ensuring more accurate and efficient breast cancer screening and providing important evidence for health policy makers, ultimately leading to better patient outcomes.



THANKS

for your attention

Contact info: shanjen8419@gmail.com

Grace Hsiao-Hsuan Jen, Ph.D

