A Systematic Review and Regression Analysis on the Value for Money of Artificial Intelligence-Empowered Precision Medicine

Yue Zhang[1], Ziwei Lin[1,2], Yot Teerawattananon[1,3], Katika Akksilp[3], Piyarat Silapasupphakornwong[3], Thamonwan Dulsamphan[3], Thittaya Prapinvanich[4], Wenjia Chen[1]

[1]Saw Swee Hock School of Public Health, National University of Singapore, Singapore; [2]Department of Emergency Medicine, Sengkang General Hospital, Singapore; [3]Health Intervention and Technology Assessment Program (HITAP), Ministry of Public Health, Thailand; [4]Yale-NUS College, Singapore.

#EE513

Background

- AI-empowered digital health tools to support precision medicine can be classified into four types:
  - Digital diagnostics, which typically combines deep learning with 3-D technologies to enhance the imaging diagnostics of various diseases.
  - Clinical risk predictions, which apply AI algorithms to predict disease disposition and progression for health triage or treatment escalation.
  - Precision medicine, which applies AI algorithms to analyze epigenomic information to prioritize therapeutic options.
  - Disease self-control, which connects AI algorithms to self-monitoring medical and treatment devices to empower disease self-management.
- To date, only two studies have narratively reviewed economic evaluations (EEs) of AI-based health technologies, prohibiting cross-study comparisons.

Objective

We aim to perform a systematic review and regression analysis on EEs of AI-PM to quantify the cost-effectiveness profiles of AI-PM and investigate heterogeneity and biases.

Methods

Systematic literature search

- Inclusion criteria: EEs on AI-PM interventions compared with non-AI interventions that were published from 2013 to 2023.
  - All types of original EEs in English were included for descriptive analyses.
- Search databases: EMBASE, Medline, Web of Science, the International HTA Database, and the Tufts Registry databases.

Statistical analyses

- **Data preparation:** we calculated net monetary benefit (NMB) per person.
  - Only cost-utility analyses were included for quantitative analyses.
  - One-time GDP per capita of the study year was used as WTP threshold.
  - All cost parameters were converted into 2023 USD.
- **Map cost-effectiveness profiles:**
  - Box plots: to summarize the distributions of △costs, △QALYs, and NMBs.
  - Mann-Whitney U test: for comparison between subgroups.
- **Identify key value drivers:** We used penalized Lasso regression with generalized linear mixed models to quantify sources of value heterogeneity.

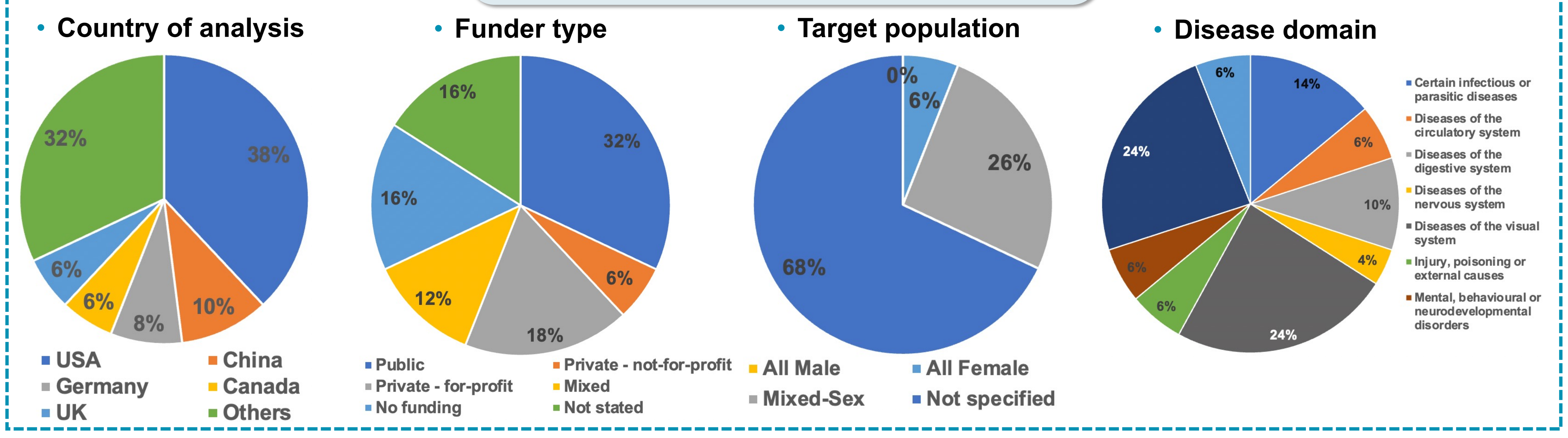
Quantifying source of value heterogeneity

Table. Results of the Lasso regression on NMB

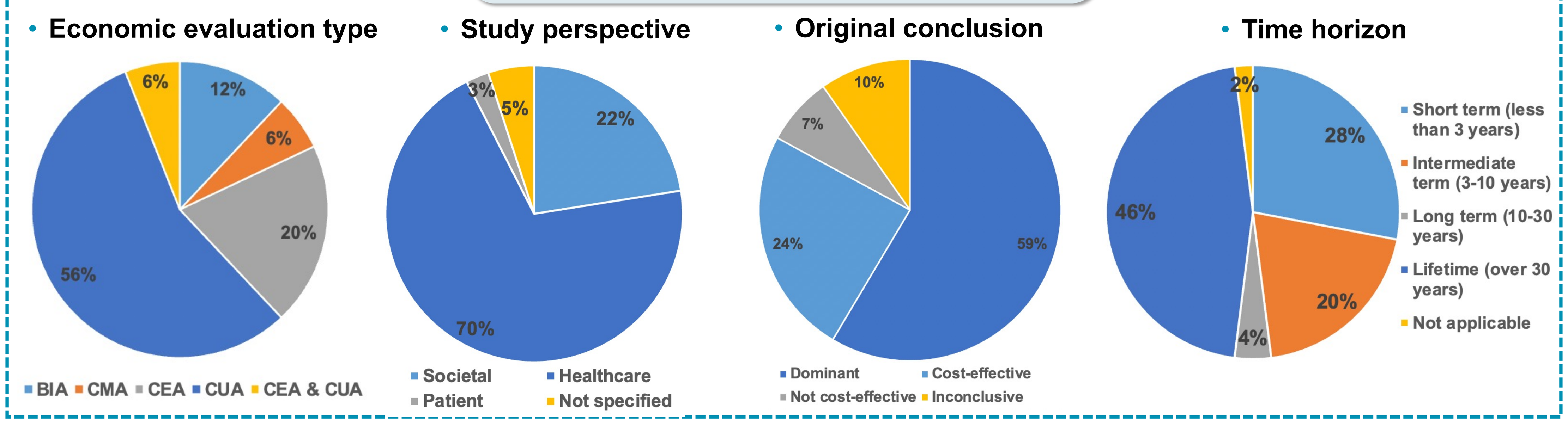
Variables	Coefficient	95% CI
Country income level		
Low or middle income	(Reference)	
High income	775.67	[-141.6, 1692.9]
Funder type		
No/Unspecified Funding Sources	(Reference)	
Public or Non-Profit Private or Mixed	520.18	[-302.5, 1342.8]
Private - for-profit	768.51	[-122.5, 1659.5]
AI-PM unit cost	2.94	[1.7, 4.2]
Type of comparators		
Current practice/standard of care	(Reference)	
New technology/best competitor	-665.45	[-1157.4, -173.5]
Integrated compliance to AI-informed intervention		
No	(Reference)	
Yes	-1199.33	[-2820.3, 421.6]
Study perspective		
Societal	(Reference)	
Healthcare system	-1299.56	[-2641.7, 42.6]
Lifetime horizon		
No	(Reference)	
Yes	-317.06	[-916.3, 282.2]

Results

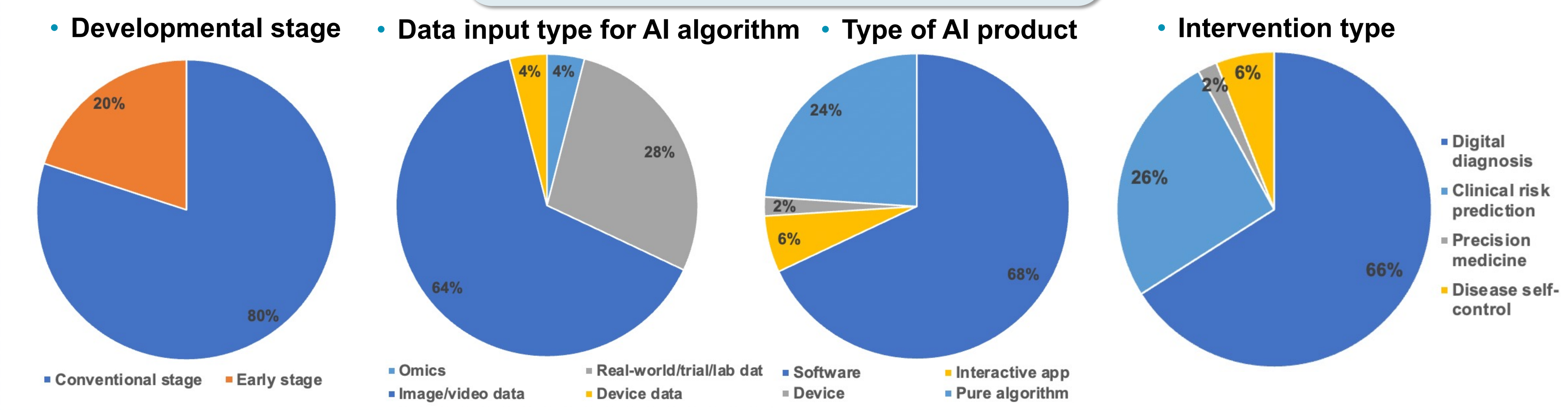
Study characteristics



EE methods



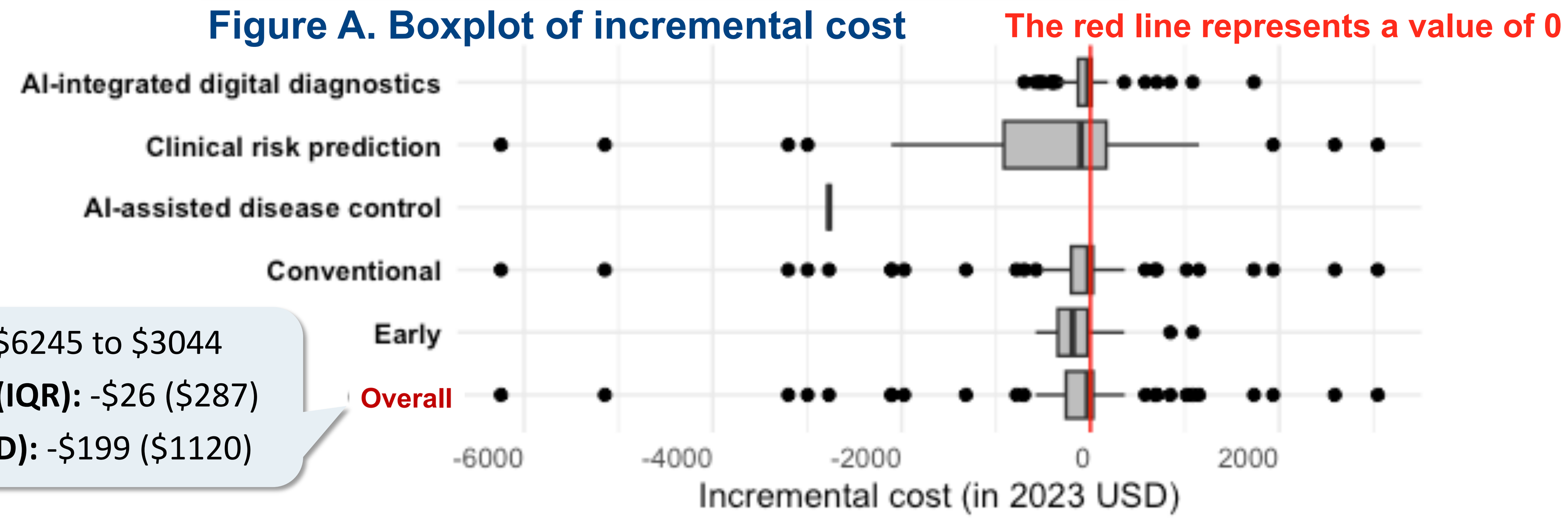
Intervention features



Mapping the cost-effectiveness profile

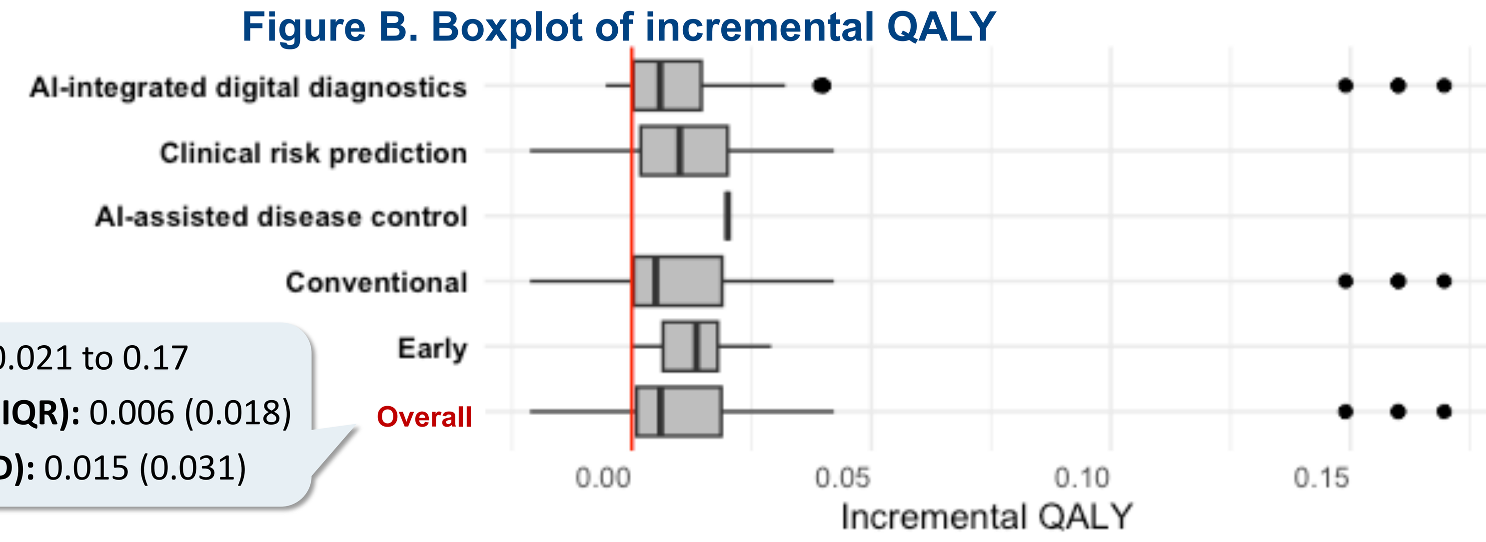
Figure A. Boxplot of incremental cost

The red line represents a value of 0



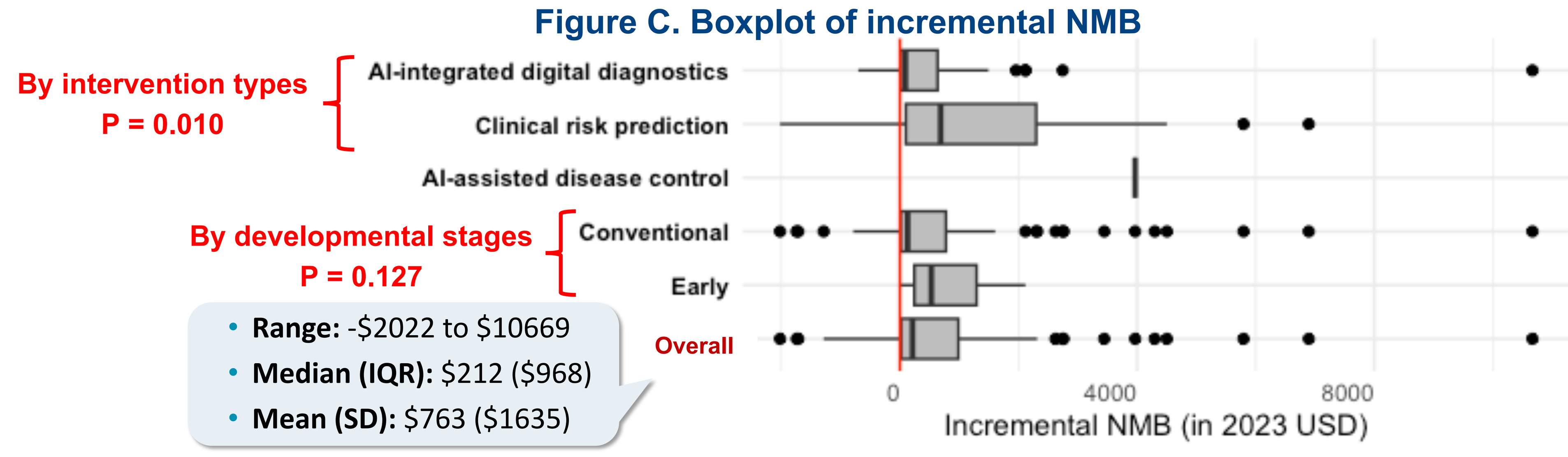
- **Range:** -\$6245 to \$3044
- **Median (IQR):** -\$26 (\$287)
- **Mean (SD):** -\$199 (\$1120)

Figure B. Boxplot of incremental QALY



- **Range:** -0.021 to 0.17
- **Median (IQR):** 0.006 (0.018)
- **Mean (SD):** 0.015 (0.031)

Figure C. Boxplot of incremental NMB



- **Range:** -\$2022 to \$10669
- **Median (IQR):** \$212 (\$968)
- **Mean (SD):** \$763 (\$1635)

Summary of findings

- Public agencies funded 1/3 of EEs on AI-PM technologies.
- The majority of EEs evaluated digital diagnostics (66%), and AI-PM tools delivered in the form of software (68%).
- 1/4 of studies evaluated an AI-PM at the early clinical stage, and reported a greater median NMB compared to conventional EE (\$530 vs. \$130).
- The median NMB of AI-PMs in general was above \$200 USD/person.
- The cost-effectiveness profile of digital diagnostic tools tend to be more stable compared to that of clinical risk prediction tools.
- A healthcare system's perspective may not capture the full value of AI-PM.
- Incompliance to AI-informed intervention greatly reduced the value of AI-PM.

Conclusion

- Studies evaluated in high-income countries, funded by private-for-profit entities, and for AI-PM interventions with higher test costs reported greater NMBs.
- Substantial heterogeneity was found in the NMBs of AI-PM interventions. Type of comparators, study perspective, integrated compliance to AI-informed actions, and time horizon were important methodological factors that may be manipulated to bias AI-PM's value.

Acknowledgement: This research was financially supported by the Health Systems Research Institute (HSRI), Thailand

Conflict of Interest: There is no conflict of interest to report