Epidemiologic Study of Health Hazards among Residents in Radiation-Contaminated Buildings
Mission-oriented Research Project

Background

- The contamination of construction steel by cobalt 60 led to 1,660 radiation-contaminated buildings (RCB) in northern Taiwan between 1982-1984.

- Since RCBs were first discovered in 1992, the Atomic Energy Council (AEC) has conducted health exams for residents who received exposure dose of more than 5 mSv in any single year (The HE for 1-5 mSv residents who lived in Taipei was provided by Taipei City Government). Until now, more than 9,000 health exams have been performed.

- The health effect induced by low-dose or low-dose rate ionizing radiation is still controversial. This study adds evidence to whether the RCBs in which those residents lived over a period of time affects their health.

Radiation-contaminated buildings

Radiation in children

Kindergarten students

Iron gratings were contaminated

Elementary school students

This playground was once contaminated classrooms

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Estimated dose distribution in 1983 for 1660 households

Estimated dose (mSv) in 1983	# of households	%
<1	533	32.11
1.01-5	435	26.20
>5	679	40.90
Missing	13	0.78
Total	1660	100.00

Objectives

- Aim: whether the RCBs in which the residents lived over a period of time affects their health.
- Examined the relationship between ionizing radiation cumulative dose and cancer risk, adjusted for confounding factors to improve the validity of the research results.
- Analysis of the relation between low-dose radiation exposure and hematological abnormalities.
- Survey of **RCB** residents' demographic characteristics, radiation knowledge, and risk awareness.
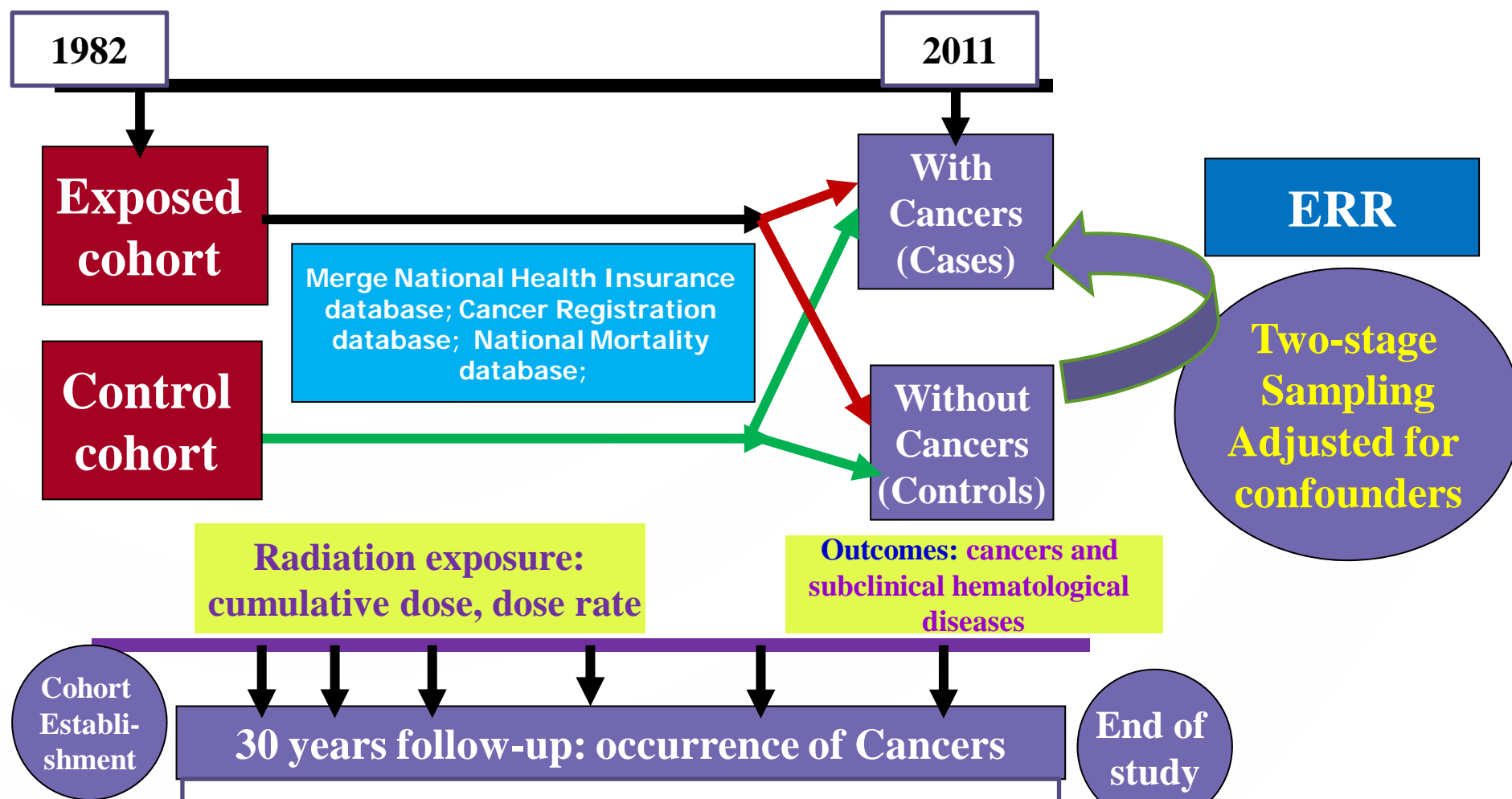
Materials & Methods

STEP 1: reconstructed the cohort of the residents in Co-60 contaminated rebar buildings.

STEP 2: reconstructed the exposure doses based on detailed dose measurements in each building and resurvey of occupancy in daily life.

STEP 3: to adjust and control for confounders in epidemiological study in order to get a valid estimation of cancer or other diseases risk.

Study Design: two-stage retrospective cohort study

Hypothesis: Low dose radiation is associated with occurrence of Cancers, hematological defects, and other abnormalities

1982 ———————————————— **2011**

Exposed cohort

Control cohort

Merge National Health Insurance database; Cancer Registration database; National Mortality database;

With Cancers (Cases)

Without Cancers (Controls)

ERR

Two-stage Sampling Adjusted for confounders

Radiation exposure: cumulative dose, dose rate

Outcomes: cancers and subclinical hematological diseases

Cohort Establi-shment

30 years follow-up: occurrence of Cancers

End of study

Content of analysis

1. Confirmed the completeness of the RCB cohort members, including RCB residents, students and staff exposed to contaminated schools, as well as employers and employees of contaminated workplaces.
2. Calculated the cumulated radiation dose for individual cohort members and used the occupancy factors to reconstruct time spent by cohort members in RCB.
3. Integrated RCB cohort members data, radiation exposure data, health examination data and questionnaire data.
4. Merged RCB cohort members data with National Health Insurance Research Database, Mortality database, and Cancer Registry, to build a health risk estimation model on radiation dose.
5. The study modified the risk assessment model of stage 1 based on stage 2 estimation to control confounding factors.

Reconstruction of the exposures for individuals

Basic Information

RCB address, Housing ownership

Renovation

1. **Renovation projects**
   - Replacement of steel reinforcement
   - Partial replacement
   - Install lead shielding
   - Removal of buildings
   - Removal of pollutants
   - Replacement of steel reinforcement by RCB residents
   - Acquired by the AEC
2. **Date of Renovation**
3. **Radiation dose rate after Renovation**
4. **Current dose rate**

Exposure Assessment of Interior Plan

1. Annual dose at time of detection
2. Date when radiation dose decayed to 5mSv or 1mSv.
3. Dose upon initial occupation
4. Occupation date
5. Detection date
6. Highly-Occupied-Zone (HOZ)
   - Living room sofa
   - Bedroom bed
   - Other (such as desk and chair, dining tables and chairs, balcony, bathroom toilet, bathtub, kitchen, front of the gas stove)

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Highly -Occupied- Zone (HOZ)
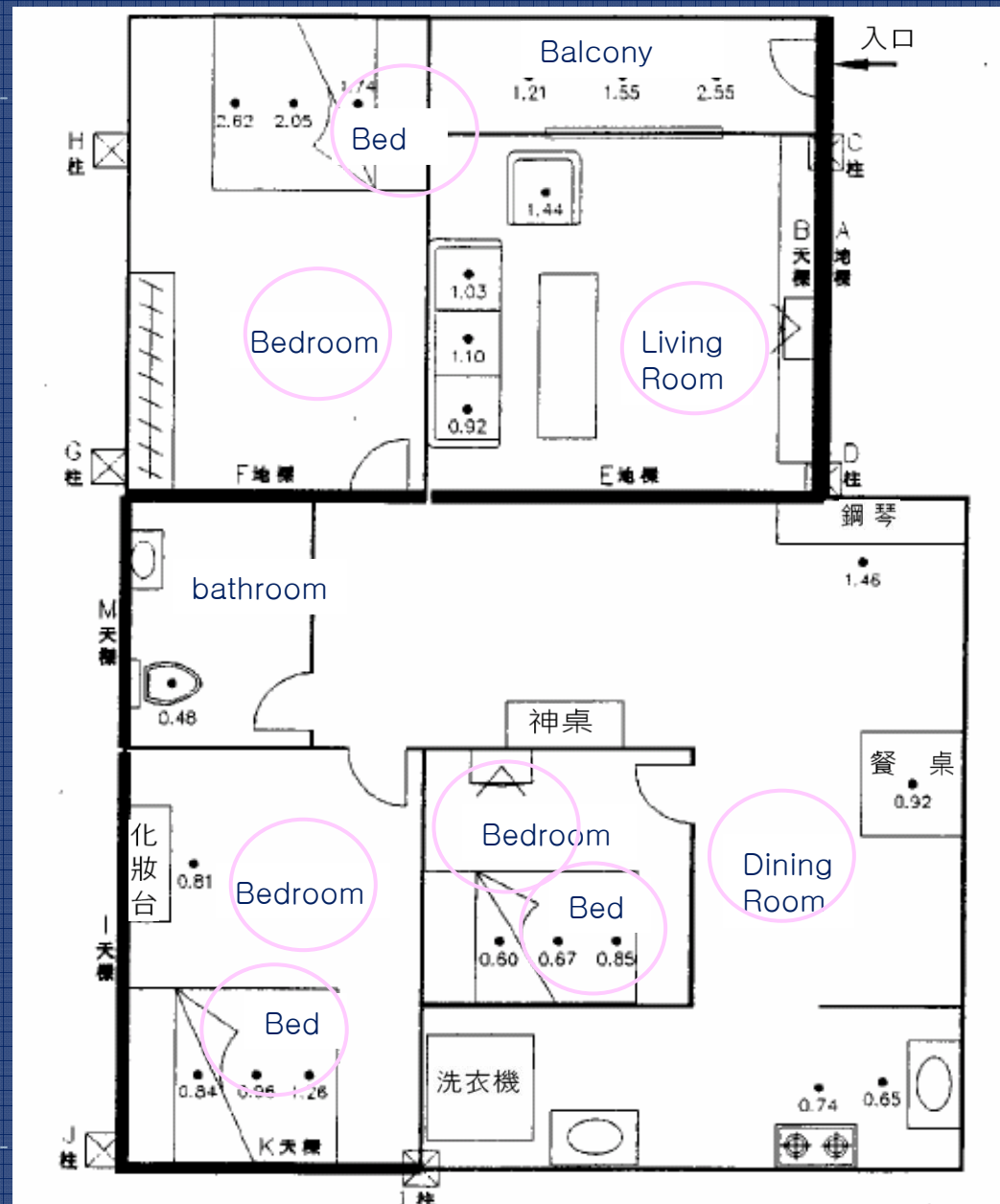
Reconstruction of the exposures for individuals

Major consideration in exposures reconstruction

1. Mean or median of specific area radiation dose rate detected by AEC.
2. Occupancy factors was used to reconstruct the amount of time spent in RCB each day by cohort member.
3. Residency and Migration of cohort members.
4. Radioactive decay of Cobalt 60.
5. Different uses of RCB such as home, office, mixed residential/commercial and school.

Reconstruction of the exposures for individuals

Table 3. Occupancy time of RCBs residents and general population of the northern Taiwan.

Status	Retrospective Occupancy factor [a] when moving in RCBs				Current Occupancy factor at 2012 [b]			
	Male		Female		Male		Female	
	n	hours	n	hours	n	hours	n	hours
Preschool	26	20.529	21	20.214	17	16.518	23	16.136
Elementary	6	14.028	4	16.646	44	13.612	39	14.112
Junior	5	13.283	6	13.375	37	12.401	39	13.699
Senior	2	16.500	6	14.222	50	12.725	53	13.015
College	6	11.708	1	12.500	98	13.728	100	14.831
Employed	57	12.665	49	14.042	635	12.731	682	13.321
Unemployed	1	11.000	--	--	32	16.146	28	16.261
Housekeeper	--	--	24	17.917	3	16.528	155	18.254
Retired	2	19.559	--	--	162	16.729	175	17.289
Total	105	13.456	111	14.822	1,078	13.619	1,294	14.703

a. Surveyed from RCBs residents.
b. Surveyed from general population in the northern Taiwan.

Two stage sampling approach

Two stage sampling approach

Stage 1: Obtained databases on radiation dose and health effects from 1982 to 2012.

The purpose was to establish a complete RCB residents cohort.

→ Build Health Risk Assessment.

Stage 2: Obtained questionnaires.

The purpose was to control confounding factors associated with cancer.

→ Adjust the health risk model.

STEP 3: to adjust and control for confounders in epidemiological study in order to get a valid estimation of cancer or other diseases risk.

- **Balanced sampling design**: increased efficiency and reduced bias (sample size=600).
- **Minimal size of RCB residents (a cell)** with cancers to be interviewed (n=60)

	Cancer	Non-Cancer	Total
Exposure	**60**	180	**240**
Non-Exposure	180	180	**360**
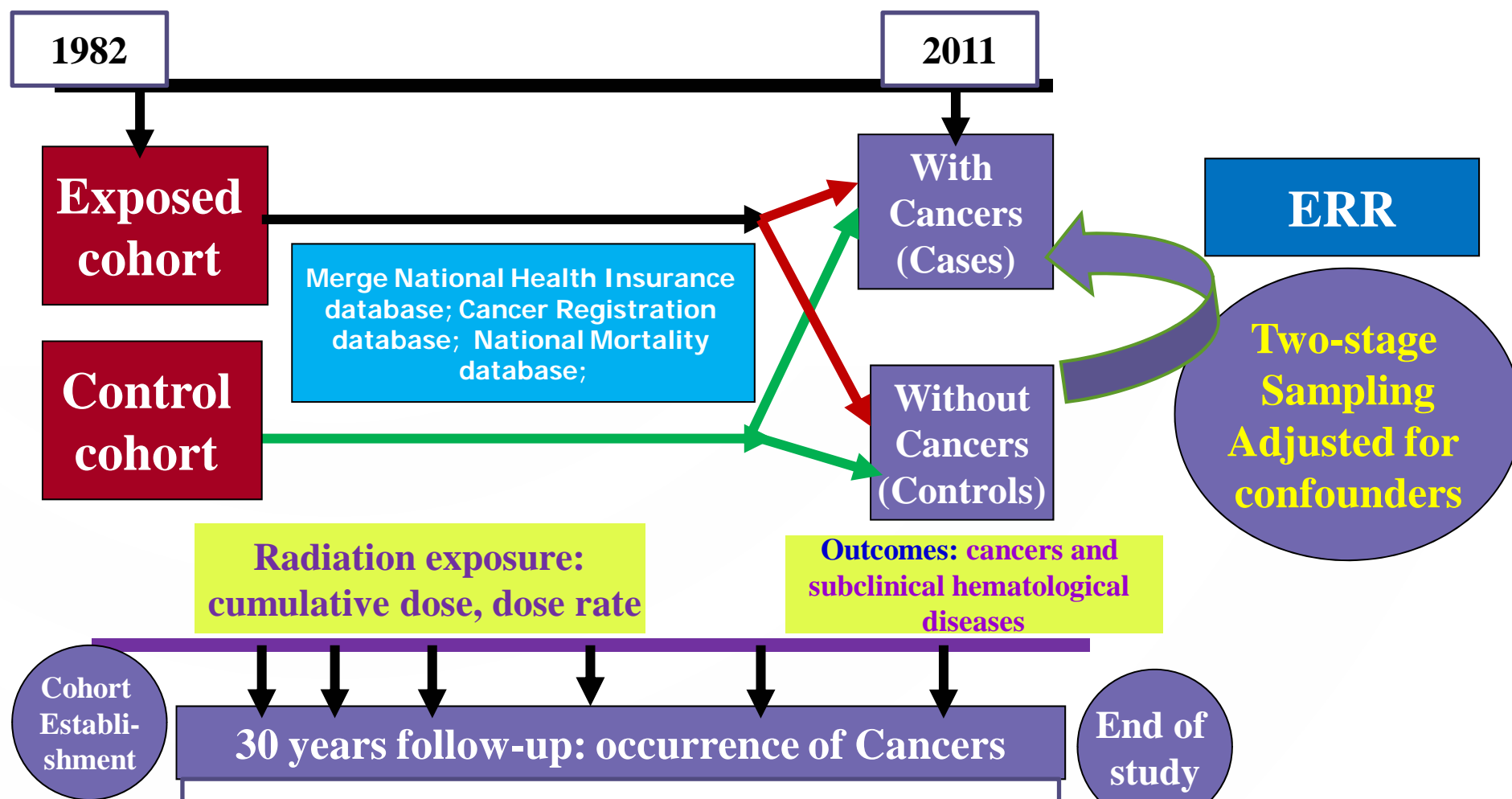
Controlling Confounding Factors of Stage 2

Confounding Factors

1.Demographic Data: Gender, age, education, income, marital status .

2.Occupational Exposure: Exposure to radiation or hazardous substances related to cancers in the workplace and the environment, shift work, etc.

3.International Flight history: Control for confounder from cosmic rays.

4.Personal Habits: smoking, drinking, exercise, diet, daily routine, etc.

5.Medical Radiation Exposure: X-ray, CT scanner , PET (Positron Emission Tomography).

Current status

‣ The consulting experts recommended that some results still be questionable and needed to be rechecked and verified.

‣ From April to May, 2014, we've done health data cross-linking and reanalysis based on the consulting experts' suggestions, in the Collaboration Center of Health Information Application (CCHIA), Ministry of Health and Welfare.

‣ We are about to call a consulting expert meeting for reviewing the reanalyzed data.

Thank you for your attention