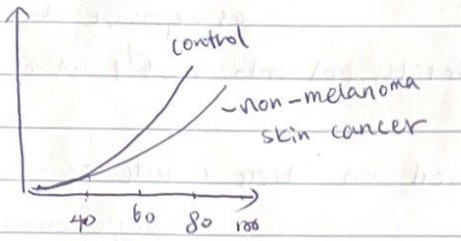
observing exposure & outcome at the same time

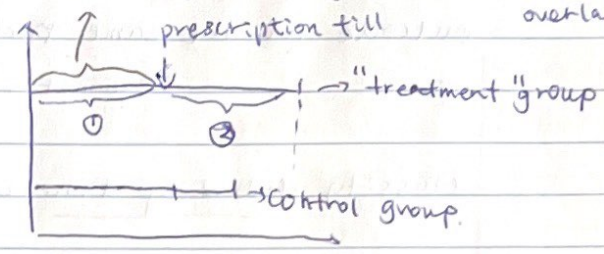
immortal time bias

(in ①, the exposure ~~status~~ & outcome ~~status~~ status are overlapping)

immortal time bias



example 1



example 2

① selection bias in the skin cancer group.

↳ to be selected as the "skin cancer" group, you need to be alive to be diagnosed as skin cancer patient. P(skin cancer | alive) which introduces selection bias.

↳ for control group, no restriction

↳ so not suprising to observe higher survival in skin cancer group

② don't condition on future event / survival be alive / be immortal

☆ ③ tricks: when classifying ppl into treat / control groups. do not use things that change over time (e.g. skin cancer diagnosis) rather, use variable that does not change over time to stratify ppl into treat / control group.

wrong analysis ← in example 2, ~~as~~ we see in the "treatment" group. in ①, ppl are not exposed. in ② time interval, ppl are exposed. so ppl in the "treatment" group are ~~not~~ ~~treat~~ both treated & untreated.

correct analysis

① by design

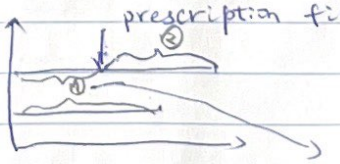
use ~~varia~~ variable that doesn't change over time to stratify treat and control.

e.g. treat: skin cancer diagnosis before age 40.

control: no skin cancer before age 40.

follow up pts from age 40.

② by analysis.



① immortal time being classified into the control group. using person-time

KM not appropriate when we're observing exposure and outcome at the same time

as exposure changes over time if ↑

so cannot stratify ppl into ~~treat~~ / control ~~in~~

Classify follow up time based on state (state is something that change over time)

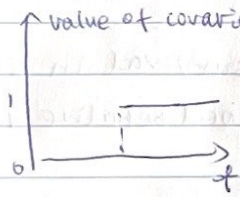
↳ follow-up time before skin cancer

↳ follow-up time after skin cancer.

cannot classify ppl into specific group.

Time-dependent covariate

counting process:



$\bar{Z}_i(t) = \{ Z_i(u) ; 0 \le u \le t \}$

↳ whole history before time t

capital Z.

↳ covariate history of i till time t.

$\lambda_i(t) = P(t \le \tilde{T}_i < t + dt \mid \bar{Z}_i(t), \tilde{T}_i \ge t)$

simplified version: if we assume that the hazard function depends only on the current value of the covariate, rather than the cumulative history:

markov type ←

$\lambda_i(t) = P(t \le \tilde{T}_i < t + dt \mid Z_i(t), \tilde{T}_i \ge t)$

↳ small t, current time