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Research paper

Differences in mortality rates between frequent and occasional participants of periodic health check-ups: An observational study and propensity analysis

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ABSTRACT

Purpose: Little is known about differences in mortality among frequent and occasional participants of health check-ups. We aimed to compare mortality of frequent and occasional participants of the annual health examination in Taiwan.
Subjects and methods: We conducted a cohort study from 2001 until 2007. There were 25,166 participants aged 65 and over in the health check-ups in 2001. Of them, 19,768 participated in the subsequent check-ups (frequent participants), but 5398 participated only once (occasional participants). The outcome measures were all-cause, cancer and cardiovascular mortalities.
Results: Compared to frequent participants, multivariate-adjusted hazard ratio (MHR) for seven-year mortality was 3.28 [95% CI: 2.98–3.62] for occasional participants. In the propensity-score-matched subsample, MHR was 3.18 [95% CI: 2.78–3.65] for occasional participants. Stratified by their participation in increasing order of frequency, all-cause mortality rates per 1000 person-year were 48.89 [95% CI: 46.40–51.37], 30.24 [95% CI: 27.98–32.50], 23.36 [95% CI: 21.27–25.46], 14.88 [95% CI: 13.18–16.58], 8.58 [95% CI: 7.26–9.89], 3.23 [95% CI: 2.46–4.00], and 0.47 [95% CI: 0.19–0.75], respectively.
Discussion: The most likely cause of mortality reduction might be the beneficial effect of subsequent referrals after health check-ups. More frequent participation ensures necessary referrals and treatment were not missed. Screening for multiple diseases detects early cases of various diseases simultaneously. Periodic health examinations also lessen patient worry and improve delivery of preventive services.
Conclusion: Occasional participants had higher mortalities as compared to frequent participants. This trend persisted after propensity matching. There was an inverse relationship between health examination participation and all-cause, cancer and cardiovascular mortalities.

1. Introduction

In the past decades, there has been a continuous rise in life expectancy in Taiwan which was 76.2 years for males and 83.0 years for females in 2012 [1]. A reduction in cancer and cardiovascular mortality and lower infant mortality may be the reasons [1].

One strategy introduced to reduce mortality in Taiwan is the periodic health check-up system, which serves as a means of early detection and referral [2]. The Taipei City government started to provide free Senior Citizens Health Examination services annually to its residents since 1991 [3]. Each year, citizens aged over 65 and native Taiwanese (aborigines) over 55 can join the health check-ups held in local hospitals. Between 1999 and 2005, about 26% of the eligible citizens underwent this preventive service [4]. The health examination consisted of physical examination, blood, urine and stool tests, Papanicolaou (Pap) smear, chest X-ray, echocardiogram, abdominal sonogram, screening for falls, depression, cognitive impairment and lifestyle risk factors. Physician's individualized explanation of the results and necessary referrals were also included.

Although the periodic health examination has been an integral part of medical practice for years, there is still no consensus on its

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long-term value [5]. Henny et al. reported a reduction in mortality in men who returned at least once to periodic health examination at age 40–59 [6]. However, little is known about the efficacy of health check-ups in older age groups. Even less is known about differences in health outcomes among frequent and occasional participants of the health examination. We aimed to compare mortality rates between frequent and occasional participants of the Senior Citizens Health Examination in Taipei City, Taiwan. We hypothesized that health examination participation is inversely associated with mortality in older people.

2. Methods

A retrospective cohort study was conducted between 2001 and 2007. This study was approved by the Institutional Review Board of Taipei City Hospital, Taiwan [TCHIRB-991227-E].

The study dataset comprised of a combination of the Senior Citizens Health Examination database and the national Mortality Registry data. The former is an administrative database produced by the Taipei City Government. It comprises data gathered from each local hospital. It covers the annual preventive service for elders delivered by hospitals with more than 27,000 records annually since 2001. The dataset contains over 300 fields including demographic and clinical information such as age, gender, medical history, screening results and laboratory test reports. The national Mortality Registry dataset contains mortality data such as identification number (ID), date and cause of death. The two dataset were matched using the participants' ID.

All community dwelling older people aged 65 and over who participated in the Senior Citizens Health Examination in Taipei City in year 2001 were included. Nursing home residents were not able to attend this hospital-based health examination and were excluded. Those who participated in the health check-ups in the subsequent years (2002–2007) but not in 2001 were also excluded. Health check-up attendance records of the participants in the subsequent years (2002–2007) were analysed. All-cause, cancer and cardiovascular mortalities were studied. According to their participation, elders were further classified into two subgroups. Those who only participated in the health examination in 2001 were defined as "occasional participants". Those who also took part in the subsequent years were grouped as "frequent participants".

The exposure of interest was voluntary attendance at the annual Senior Citizens Health Examination between 2001 and 2007. Demographic data, self-reported lifestyle habits, medical history, and laboratory test results in the baseline year (2001) were included in this analysis.

The main outcome was all-cause mortality between 2001 and 2007. Cancer and cardiovascular mortalities were also analysed. The 9th International Classification of Diseases (ICD-9) was used for coding. The mortality rates were further stratified by the elder's participation in the health examination, from once in 2001 to a maximum of seven times. The denominator for mortality rates was the person-year in each of the seven subgroups, according to their participation.

3. Statistical analyses

Statistical analysis was performed with SAS version 9.1.3 (SAS Institute Inc, North Carolina, USA). *P*-values < 0.05 in two-sided analyses were considered significant. Cox proportional hazards model was used to calculate the hazard ratio for seven-year mortality. Frequent participants were considered as the reference group. Only statistically significant variables in the univariate model were included in the multivariate model. Confidence intervals (CI) for multivariate hazard ratio (MHR) for seven-year-mortality were calculated. To minimize reverse causality, the analysis was rerun after excluding participants who died within the first three years. Additionally, the cohort of year 2003 was analysed in the same way. We also performed a sub-analysis in the old-old population (aged 75 and over).

To further reduce bias, a propensity score approach was used to investigate the relationship between utilization of health check-ups and mortality. The propensity score as a binary dependent variable was the conditional probability for the elders to attend health check-ups under a set of measurements. Age, gender, medications taken for over 6 months, pre-existing hypertension, coronary artery disease, diabetes mellitus and stroke were added into a multivariable logistic regression model. C statistics and R-squared of the model were 0.77 and 0.14, respectively. The predicted probability from the logistic regression analysis was used as the propensity score for each participant regardless of outcome. We matched one frequent participant to one occasional participant.

4. Results

There were in total 27,014 participants in 2001; 1848 participants under 65 were excluded, leaving the study population at 25,166 people. Of these, 19,768 also participated in the subsequent health check-ups (frequent participants) while 5398 participated only once in 2001 (occasional participants).

Table 1 shows the baseline characteristics. The proportion of smokers was lower among frequent participants (frequent *vs.* occasional participants: 9.4% *vs.* 12.7%), but the proportion of drinkers was higher (16.6% *vs.* 13.3%). A lower proportion of frequent participants had known coronary artery disease (11.3% *vs.* 14.6%), while a higher proportion of frequent participants had a history of chronic kidney disease (8.7% *vs.* 7.1%).

Table 2 shows the multivariate Cox proportional regression analysis of the factors associated with seven-year-mortality (year 2001–2007). Advanced age (MHR, 1.08; 95% CI, 1.07–1.09), male gender (MHR, 1.84; 95% CI, 1.63–2.09), smoking (MHR, 1.22; 95% CI, 1.06–1.41), accidental falls (MHR, 1.45; 95% CI, 1.17–1.80), having coronary artery disease (MHR, 1.29; 95% CI, 1.12–1.49) or stroke (MHR, 1.14; 95% CI, 1.02–1.28) were all associated with increased mortality, whereas drinking alcohol (MHR, 0.78; 95% CI, 0.68–0.90) and a higher BMI (MHR, 0.96; 95% CI, 0.94–0.97) were protective factors for mortality. A low rate of participation in health examinations was associated with increased all-cause mortality (MHR 3.28, 95% CI, 2.98–3.62).

When participants who died during the first three years of follow-up were excluded, this approach did not change the trend substantially (MHR for four-year-mortality 1.70, 95% CI, 1.54–1.88). The same trend was again observed when analysing the cohort of year 2003 (MHR for five-year-mortality, 1.39; 95% CI, 1.28–1.52) and the old cohort (n = 10,229) (MHR 2.87, 95% CI, 2.62–3.14) (data not shown).

During seven years of follow-up, the all-cause mortality rate (per 1000 person-years) was lower among frequent participants (13.49; 95% CI, 12.85–14.13) than that among occasional participants (48.89; 95% CI, 46.40–51.37). This tendency was similar for cardiovascular and cancer mortality rates (Supplementary data, Figure).

For the propensity matched sub-cohort analysis, 5321 propensity matched pairs were selected. Significant differences were not found in the baseline characteristics (Table 3). Frequent participants consistently showed a better seven-year-survival as compared to occasional participants (Fig. 1).