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Lifestyle, socioeconomic characteristics, and medical history of elderly persons who receive seasonal influenza vaccination in a tax-supported healthcare system

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ABSTRACT

Background: Observational studies on effectiveness of influenza vaccination in the elderly are thought to be biased by healthier lifestyles and higher socioeconomic status among vaccinated vs. unvaccinated persons. We examined this hypothesis in a uniform tax-supported health care system with free-of-charge influenza vaccination to the elderly.

Methods: We conducted a cross-sectional study among Danes aged 65–79 years participating in a survey. We compared elderly persons with and without a recent (within six months) influenza vaccination in terms of (i) lifestyle and socioeconomic characteristics obtained from the survey and (ii) health factors including medical history provided by Danish registries. We compared the prevalence of study variables among vaccinated and unvaccinated persons using age- and sex-adjusted prevalence ratios (aPRs) with 95% confidence intervals (CIs).

Results: Among the 4237 elderly persons completing the survey, 1718 (41%) had received an influenza vaccination. Vaccinated persons had more comorbidity than unvaccinated persons (aPR for high comorbidity level: 1.51 95% CI 1.24–1.84), were less likely to never have smoked (aPR: 0.88, 95% CI 0.80–0.97), and had a higher prevalence of physical inactivity (aPR: 1.08, 95% CI 1.03–1.13). Levels of education and income were similar in the two groups. Vaccinated persons had a higher prevalence of major physical limitations (aPR: 1.40, 95% CI 1.17–1.66) and need for assistance with activities of daily living (aPR: 1.29, 95% CI 1.13–1.47).

Conclusion: Elderly influenza vaccinated persons were not healthier in terms of lifestyle and burden of disease, did not have a higher socioeconomic status, and were more frail than unvaccinated persons.

1. Introduction

The benefits of influenza vaccination in elderly persons (age ≥ 65 years) have been questioned due to the age-dependent decline of immune responsiveness [1]. Despite of this, several observational studies have reported that influenza vaccination among elderly persons is associated with a 20–25% lower risk of hospitalization for pneumonia and influenza, as well as an up to 50% lower risk of death during the influenza season, compared with unvaccinated elderly persons [2–4]. However, the reported beneficial effects may be due to healthy-user bias [5,6]. In 2006, Jackson et al. [7] found a significantly protective effect of influenza vaccination on mortality even in the pre-influenza period among elderly influenza vaccinated persons within a health maintenance organization in the US. Jackson et al.'s findings were confirmed by several later studies conducted in similar settings [8–11]. The results indicate bias, since the observed positive effects associated with influenza vaccination likely extend beyond the vaccine itself. This is further emphasized by the fact that the effects were unchanged in years with low match between the vaccine and the influenza strain [3,8]. The presumed underlying bias in previous studies seems to have two components: (i) a healthy-user bias, *i.e.*, increased awareness and focus on health among vaccinated individuals; and (ii) a frailty bias, *i.e.*, use of a comparison group

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including individuals with a short life expectancy who are not offered influenza vaccination [6,10]. Both biases are thought to amplify the observed positive outcome of influenza vaccination.

The studies suggesting these biases were performed in the US, and factors related to the US healthcare system may have contributed to the results. Importantly, although Medicare provides free influenza vaccine to the elderly, socioeconomic factors remain important determinants of influenza vaccine receipt in this population in the US [12]. A similar pattern has been found in studies from countries where reimbursement of the costs of influenza vaccination depends on health insurance coverage, e.g. in Austria, South Korea and Iran [13–15]. In contrast, studies conducted in a range of European countries where vaccination of elderly persons is also provided free-of-charge found that (socio)economic factors such as income and educational level were not major determinants of vaccination [13,16].

We therefore hypothesized that in the context of influenza vaccination among elderly persons, the healthy-user effect is limited in a uniform tax-supported healthcare system providing influenza vaccination free-of-charge to at-risk individuals. If our hypothesis is confirmed, it would be informative to conduct future studies on outcomes of influenza vaccination within such healthcare systems. We conducted a cross-sectional study exploring lifestyle, health profile, and socioeconomic characteristics among vaccinated and unvaccinated elderly persons in Denmark, using data from a public health survey and from Danish health registries.

2. Methods

2.1. Study design and setting

This cross-sectional study was based on a public health survey conducted in the Central Denmark Region in 2006, linked with several medical databases at the individual level. About 1.2 million of the total 5.6 million Danish residents live in the Central Denmark Region.

The Danish healthcare system provides all Danish residents with equal tax-supported access to primary and secondary care. At birth or upon immigration, each Danish resident is assigned a unique 10-digit personal identifier (“CPR number”), which is used to record every contact with the healthcare system [17]. This allows accurate, unambiguous individual-level linkage among all Danish health and administrative registries [18]. All codes used in this study to identify variables in these registries are provided in the Appendix.

2.2. Study population

In February 2006 the Centre for Public Health, Central Denmark Region, conducted a questionnaire-based public health survey called “Hvordan har du det?” (“How Are You?”) [19]. A random sample of 31,500 eligible participants (Danish citizens aged 25–79 years living in the Region at the time, with at least one parent born in Denmark) was identified through the Civil Registration System. A questionnaire containing approximately 400 questions on self-evaluated health, presence of chronic diseases, socioeconomic characteristics, and lifestyle factors was delivered by mail along with a stamped return envelope. Up to three reminders were sent to non-respondents.

A total of 21,708 persons (69%) completed and returned the questionnaire. The date of questionnaire completion for a given person was considered his or her ‘index date’. The current study was limited to the 4237 responders aged 65–79 years.

2.3. Seasonal influenza vaccination

In Denmark, seasonal influenza vaccination is provided free-of-charge to at-risk groups [20], (including persons aged 65 years or older), predominantly by community-based general practitioners (GPs). The vaccine can be administered in patients’ homes or in nursing homes without additional cost to the GP or the patient. Most primary care services in Denmark are fully reimbursed by the National Health Insurance. We obtained data on influenza vaccination registered as primary care services in the Central Denmark Region. Data included service description and code, date of service, and patient CRP number. We divided our study population into vaccinated and non-vaccinated elderly persons, based on data on reimbursement of influenza vaccination during the period from 6 months before to 6 months after the date of questionnaire completion.

There were no limitations in the supply of influenza vaccines during the two influenza seasons covered by the study period. The recommendations for influenza vaccination of elderly in Denmark during the study period are consistent with current recommendations [21–23].

2.4. Comorbidity

Information on study participants’ morbidity was obtained from the Danish National Patient Registry (‘Patient Registry’). The Patient Registry contains primary and secondary discharge diagnoses and procedure codes [coded according to the *International Classification of Diseases, Tenth Edition* (ICD-10)] for each hospital admission since 1977 and for outpatient visits and emergency room visits since 1995 [24]. The overall quality and accuracy of data in the Patient Registry has been found to be high [24]. We searched the Patient Registry for diagnoses corresponding to the 19 major disease categories included in the Charlson Comorbidity Index (CCI) [25] and extracted diagnoses registered within five years before the index date. For each individual, a comorbidity score (0 = no comorbidity, 1 = mild comorbidity, 2 = moderate comorbidity, $\geq$3 = severe comorbidity) was calculated. For some important conditions most often handled in primary care and treated pharmacologically with disease-specific drugs (*i.e.*, diabetes, dementia, and chronic obstructive pulmonary disease) and thus potentially underreported in the hospital-based database [26], we used prescriptions filled within a year before the index date as proxies for the diseases being treated. Prescriptions were identified from the Aarhus University Prescription Database (‘Prescription Registry’). The Prescription Registry contains data on all reimbursed prescriptions filled at pharmacies in the Central Denmark Region. Prescription Registry data include CPR number, Anatomical Therapeutic Chemical (ATC) code, medication name, and date of redemption [27].

2.5. Lifestyle, socioeconomic characteristics, and health factors

We collected information on factors and characteristics suggested in the literature as potentially relevant to the healthy-user effect, including lifestyle factors, socioeconomic characteristics, as well as markers of health awareness and frailty [6,8,10,11].

All information on lifestyle and socioeconomic factors was retrieved from the “How Are You?” study database, which contains participants’ responses to individual questionnaire items. Lifestyle factors included (i) body mass index calculated using self-reported height and weight and categorized according to the World Health Organization categories [28]; (ii) frequency of physical exercise (regularly, irregularly); (iii) dietary habits categorized as healthy, reasonably healthy, or unhealthy, based on 30 questions regarding intake of fruit, vegetables, fish, and fat [29]; (iv) smoking status

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