Clinical Nutrition ESPEN 10 (2015) e71–e76

Contents lists available at ScienceDirect

Clinical Nutrition ESPEN

journal homepage: http://www.clinicalnutritionespen.com

Original article

# Soft drink consumption and multimorbidity among adults

Zumin Shi [a, *], Guillaume Ruel [a, b], Eleonora Dal Grande [a], Rhiannon Pilkington [a], Anne W. Taylor [a]

[a] Discipline of Medicine, University of Adelaide, South Australia, Australia
[b] Direction québécoise de cancérologie, Québec, Canada

ARTICLE INFO

*Article history:*
Received 19 March 2014
Accepted 10 January 2015

*Keywords:*
Soft drink
Multimorbidity
Australia
Epidemiology

SUMMARY

*Background and aims:* We aimed to examine the association between soft drink consumption and multimorbidity among adults in South Australia.

*Methods:* Data were collected using a risk factor surveillance system between 2008 and 2013. Each month a representative random sample of South Australians are selected from the Electronic White Pages with interviews conducted using Computer Assisted Telephone Interviewing (CATI). We define multimorbidity as currently having two or more of nine chronic conditions: asthma, diabetes, hypertension, high cholesterol, cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), mental health problems, osteoporosis, and arthritis.

*Results:* Among 36,663 participants aged over 16 years old, 10.5% reported daily soft drink consumption of more than half a litre and 28.5% had multimorbidity. Soft drink consumption was positively associated with all nine chronic diseases except osteoporosis. High levels of soft drink consumption were positively associated with multimorbidity and increased with the number of chronic diseases. In the multivariable analysis, after adjusting for socio-demographic and lifestyle factors, comparing those who consumed more than half a litre of soft drink per day with those not consuming soft drink, the relative risk ratios (RRRs) for multimorbidity were 1.87 (95% CI 1.61–2.17) and higher for women 2.18 (95% CI 1.78–2.66). Multimorbidity prevalence increased with age but its association with soft drink consumption was stronger in those under 60 years old. In 2008, close to one out of three participants with multimorbidity had a high level of soft drink consumption. The prevalence of high levels of soft drink consumption decreased over the five years.

*Conclusion:* There is a positive association between consumption of soft drink and multimorbidity among adults in South Australia and this relationship is stronger in younger people. This has implications for population level strategies to reduce the risk of developing chronic diseases and multimorbidity.



## 1. Introduction

Multimorbidity is the coexistence of two or more chronic conditions in an individual and has been shown to be common worldwide [1]. It is related to increased health service use and medical costs as well as poor quality of life [1,2]. The prevalence of multimorbidity increase with ageing and varies between populations from 3.5% to 89.5% depending on numerous factors such as the definition used, number of chronic diseases included, population characteristics and data sources [3]. In Australia, a population based study showed that 39.2% of those aged 60 and above have multimorbidity [4].

Among many factors, an unhealthy lifestyle contributes to the development of chronic diseases. Studies on the association between diet and multimorbidity are limited [5]. Based on a cohort study among Chinese adults, we have shown that high intake of fruit, vegetable and whole grains are associated with lower risk of developing chronic diseases and multimorbidity [5]. However, in many parts of the world, a traditional healthy diet has been replaced by a high energy density western diet. One important component of the western diet is soft drink. Soft drink has been found to be associated with an increased risk of obesity [6] and a range of other chronic diseases including diabetes [7],

* Corresponding author. Discipline of Medicine, University of Adelaide, 122 Frome Street, South Australia 5000, Australia. Tel.: +61 8 8313 1188; fax: +61 8 8313 1228.
*E-mail address:* zumin.shi@adelaide.edu.au (Z. Shi).

http://dx.doi.org/10.1016/j.clnesp.2015.01.001
2405-4577/

cardiovascular diseases (CVD) [8], asthma [9], metabolic syndrome [7], and mental health problems [10]. Some chronic diseases share some common physiological characteristics such as increased inflammation [11] or obesity. It is well known that obesity is related to inflammation. In a randomised controlled crossover trial, Aeberli et al. reported that sugar sweetened beverage consumption in small to moderate quantities for 3 weeks increases the level of inflammatory biomarker high sensitivity C-reactive protein by more than 60% [12].

Australia is one of the countries with the highest consumption of soft drink in the world. The intake of soft drinks in Australia has grown rapidly from around 47.3 L in 1969 to 113 L per person per year (children and adults) in 1999 [13]. The main goal of the present study was to 1) assess the association between soft drink consumption and multimorbidity; and 2) describe the trend of soft drink consumption between 2008 and 2013 among participants aged 16 years and over using data from a risk behaviour surveillance system in South Australia (SA). The main hypothesis was that soft drink consumption was associated with multimorbidity and that consumption has increased in the last five years.

## 2. Methods

### 2.1. Survey design and sample selection

Data for this cross-sectional study were collected using the South Australian Monitoring and Surveillance System (SAMSS) from March 2008 to June 2013. SAMSS is designed to systematically monitor the trends of diseases, health related problems, behavioural risk factors and other health service issues over time for the SA health system, as previously described [9]. Briefly, SAMSS utilises a Computer Assisted Telephone Interviewing (CATI) system to conduct the interviews. Each month, approximately 600 completed interviews (7200 per annum) are conducted on randomly selected people of all ages (between April 2010 and August 2010 about 1200 participants were recruited each month). All households in SA with a telephone number listed in the telephone directory are eligible for selection in the sample. A letter introducing the survey is sent to the selected household. Interviews are conducted by trained health interviewers with the last family member to have a birthday was chosen for interview. There are no replacements for non-respondents. Up to ten call backs are made to the household to interview the selected persons. Data are weighted by area (metropolitan/rural), age, gender and probability of selection in the household to the most recent SA population data so that the results are representative of the SA population.

In the period from March 2008 to June 2013, a total of 36,714 interviews were conducted on those aged 16 years and over and the response rate was about 60%. In total, 47 participants were excluded from the analysis because of missing information on soft drink or chronic diseases.

### 2.2. Components and definition of multimorbidity

Chronic conditions included in the definition of multimorbidity were self-reported, diagnosed by a doctor for asthma, CVD, hypertension, chronic obstructive pulmonary disease (COPD), diabetes, arthritis, and osteoporosis, or currently under treatment for high cholesterol or mental health condition. The question used in assessing individual chronic disease was “Have you ever been told by a doctor or a nurse that you have (disease name, e.g. hypertension)?”. Multimorbidity was defined as the presence of two or more of these nine conditions consistent with previous definition [14].

#### 2.2.1. Soft drink, fruit and vegetable, and alcohol consumption

Soft drink consumption was assessed by the question “On average, how many litres of soft drink and sports drink (eg Coke, lemonade, flavoured mineral water, Powerade, Gatorade) do you usually have in a day?” Participants were also asked how many glasses of water and juice they have in a day. Partial fluid consumption was constructed based on the consumption (in litres) of soft drink, water and fruit or vegetable juice. Participants were asked how many servings of fruit and vegetables they usually ate per day. The fruit and vegetable consumption variable was divided into those eating less than current government recommendations (two serving of fruits and five of vegetables per day) and those eating at the recommendation level or more [15]. Participants were also asked about their usual alcohol consumption.

#### 2.2.2. Demographic variables

Sex, age, area of residence, highest educational attainment and gross annual household income were included in the analyses. The socioeconomic variables have been tested for their reliability by the CATI Technical Reference Group (TRG), National Public Health Information Working Group (NPHIWG) in 2001–2004. As a result of this evaluation of the questions, the members of CATI TRG have collaborated to produce modules of question sets for use in CATI surveys in Australia. These questions are part of the National Health Data Dictionary.

#### 2.2.3. Other measurements

A measure of physical activity was derived from the sum of the time spent undertaking walking, moderate and/or vigorous activity in a one week period, with vigorous activity doubled to account for its greater intensity [16]. Sufficient activity to provide a health benefit was defined as physical activity greater than or equal to 150 min/week. Body mass index (BMI) was derived from self-reported weight and height. Overweight was defined as BMI $\geq$25 kg/m$^2$ but <30 kg/m$^2$. Obesity was defined as BMI $\geq$30 kg/m$^2$. Smoking status was also determined.

### 2.3. Data analyses

Chi square tests were used to compare differences in categorical variables. The association between soft drink consumption and the risk of multimorbidity was analysed using logistic regression models or multinominal logistic regression depending on the outcome variables (binary or more than binary), adjusting for multiple covariates. The multivariable models controlled for age (continuous), gender, education, income, residence, smoking, alcohol consumption, physical activity, intake of fruit and vegetables, and overweight/obesity (yes/no). A test for trend of the risk of multimorbidity across groups of soft drink consumption was undertaken by putting medium intake in each group as continuous variables in the logistic regression. All data presented in this paper are weighted estimates and all the analyses were performed by using STATA software (version 13, StataCorp, College Station, TX).

### 2.4. Role of the funding source

The study sponsors did not contribute to the study design and had no role in data collection, data analysis, data interpretation, or writing of the report.

Ethical approval for the project was obtained from University of Adelaide (ethics approval number H-182-2009) and SA Health (approval number 436/02/2014). All participants gave informed consent.