A population-based analysis of long-term sedative use among community-dwelling adults

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Keywords: Benzodiazepines, sedatives, trends, prescribing, age

Abstract

Background: Chronic use of benzodiazepines and benzodiazepine-like sedatives (z-drugs) presents substantial risks to individuals of all ages. We assess trends in long-term sedative use among community-dwelling adults in British Columbia.

Methods: Using population-based linked administrative databases, we examined longitudinal trends in age-standardized rates of sedative use among different age groups of community-dwelling adults age 18 and older from 2004 to 2013. For each calendar year, we classified adults as non-users, short-term users, or long-terms users of sedatives based on their patterns of sedative dispensations. For calendar year 2013, we applied cross-sectional analysis and estimated logistic regression models identifying health and socio-economic risk factors associated with long-term sedative use.

Results: More than half (53.4%) of long-term users of sedatives in British Columbia are between ages 18 and 64 (young/middle-aged adults). From 2004 to 2013, long-term sedative use remained stable among adults over age 65 (older adults) and increased slightly among young/middle-aged adults. While use of benzodiazepines decreased during the period, that trend was offset by equal or greater increases in long-term use of z-drugs. Being older, sicker, poorer, and single were associated with increased odds of long-term sedative use.

Interpretation: Despite efforts to stem such patterns of medication use, long-term use of sedatives increased in British Columbia between 2004 and 2013, driven largely by increased prevalence among middle-aged adults. Future deprescribing efforts targeting adults of all ages may be more successful.

Trial registration: Not applicable

Benzodiazepines and benzodiazepine-like sedatives (zopiclone, zolpidem, and zaleplon), termed z-drugs, are commonly prescribed to treat anxiety and insomnia but are contraindicated for long-term use (1,2). Chronic use of sedatives presents serious risks, including dependence, abuse, and cognitive and psychomotor impairment (3-6). Numerous efforts have aimed to curb long-term sedative use, particularly among older adults, yet these policies have not had significant effects (7-10). Most efforts to curb chronic sedative prescribing have focused on benzodiazepines, ignoring z-drugs despite indications that recent prescribing trends favor z-drugs over benzodiazepines (11-13). Stable trends in long-term sedative dispensing may mask underlying variation in benzodiazepine and z-drug dispensing. Indeed, decreases in benzodiazepine dispensing accompanied by concurrent increases in z-drug dispensing, are documented in Europe (14-16). Little is known about long-term sedative use in North American settings. Furthermore, existing studies of long-term sedative use primarily focus on older adults (17-20). Yet, long-term sedative use among younger adults is also contraindicated and is worthy of examination.

We assess trends in benzodiazepine and z-drug dispensations among all community-dwelling adults in British Columbia (BC), Canada from 2004 to 2013. We determine the extent to which patterns of sedative use vary by age and sex and identify medical and socio-economic risk factors associated with long-term sedative use for adults over and under age 65. Given that past research shows women are more likely to receive prescriptions for sedatives than men (7,8,14,21), we sex-stratified our analyses where appropriate.

Methods

Data

We based our retrospective analysis on de-identified linked health datasets provided by Population Data BC with approval of relevant data stewards (22-24). Datasets included information on all British Columbians over age 17, except those whose prescription drug coverage fell under federal jurisdiction (military veterans, registered First Nations and Inuit, and federal penitentiary inmates, which collectively make up ~4% of BC's population). To ensure complete pharmaceutical data capture, we only included individuals living in BC for at least 275 days in any year from 2004 until 2013. Similar to past studies (19,21), we focused our analysis on community-dwelling adults and excluded long-term care facility residents (0.7% of the population and 3% of sedative users).

Data on pharmaceutical dispensations came from PharmaNet, an information system into which pharmacists must, by law, enter records of every prescription dispensed outside of acute care hospitals (25). We grouped prescription drugs according to the World Health Organization's Anatomical Therapeutic Chemical (ATC) drug classification system (26). We identified benzodiazepine and z-drug prescriptions using ATC level 5 codes (Appendix A).

We linked prescription history to hospital discharge data containing up to 25 diagnosis codes (ICD-10) per hospitalization and to medical services data from the BC Medical Services Plan Payment File, which included one primary diagnosis code (ICD-9) for every fee-for-service medical visit. Hospital services data came from the Discharge Abstract Database, which tracks in-patient separations from all hospitals in BC. We did not have access to medical services data for care funded by alternative payments (e.g., capitation funded health clinics). We therefore

excluded a small number of geographic areas (e.g., northern and inner-city communities) that receive 25% or more of their medical care from non-fee-for-service providers. This exclusion affected an additional 4% of the study population.

Derived Variables

We used the John Hopkins Adjusted Clinical Group (ACG version 10.0) case-mix adjustment system to adjust for health status (27). Specifically, we constructed a count of the number of major and number of minor Aggregated Diagnostic Groups (ADGs). Counts of ADGs are predictive of mortality and health services utilization (28,29).

We estimated household income based on a combination of household-specific and area-based income data (30). For 52% of the population, we had validated, household-specific income information from registration files for BC's income-based public drug plan (Fair PharmaCare). For the remaining 48% of the population, we estimated household income based on median household income for the Census Dissemination Area in which people lived. Individuals with missing household and area-based income data were excluded from the analysis (~2%).

Prior research suggests there may be ethnic differences in use of medicines as a result of cultural, environmental, and biologic factors (31-34). We sought to identify whether likelihood of long-term sedatives use varies according to ethnicity. Since there are no population-based sources of information on ethnicity that could be linked to our datasets, we estimated ethnicity using a validated algorithm developed to identify surnames of South Asian and Chinese origin (35).

Definitions

For each calendar year, we classified adults as non-users, short-term users, or long-terms users of sedatives based on their dispensation history. We classified individuals as long-term sedative users if they filled prescriptions totaling more than 90 days' supply of benzodiazepines or z-drugs in the calendar year. We identified short-term sedative users as those who filled at least one sedative prescription and had 90 or fewer days of therapy dispensed.

Most guidelines recommend limiting sedative use to less than 28 days (36,37). Our definition of long-term use is a conservative estimate, consistent with other studies (7,38), and ensures that most individuals classified as long-term users have filled more than three sedative prescriptions in the year, given BC's public drug plan restricts dispensations of sedatives to 30 days of therapy (39).

Statistical Analysis

When reporting prevalence rates for the adult population, we age-standardized annual statistics using the 2013 population in four age categories (18–44, 45–64, 65–84, and 85+). We termed adults between ages 18 and 44 young adults, those between ages 45 and 64 middle-aged adults, and those over age 65 older adults. We based these definitions on past studies examining benzodiazepine use in different age groups (40).

We studied medical and socio-economic risk factors associated with different levels of benzodiazepine use in 2013. We estimated age and sex-stratified and sex-pooled logistic regression models, incorporating explanatory variables based on well-established models of health services utilization (41,42). We included measures of sex, age, health status, income,

marital status, ethnicity, and neighborhood urbanization in our models. All analysis was conducted in Stata 13 (43).

Ethics Approval

The University of British Columbia's Behavioural Research Ethics Board approved this study.

Results

The population of community-dwelling adults meeting our study inclusion criteria grew from 2.94 million in 2004 to 3.22 million in 2013. These adults represented approximately 75% of the total population of the province. The study characteristics of community-dwelling British Columbians who met our inclusion criteria in 2013 are summarized in Table 1. Long-term users were most likely to be women, to be older, to have low incomes, and to have relatively poor health status. Conversely, non-users were most likely to have surnames of Chinese origin.

Among young/middle-aged adults, long-term use of sedatives was most common among individuals aged 45 to 64 and among older adults, long-term use was most common among individuals aged 65 to 84 (Appendix B). Further, despite differences in population prevalence of long-term sedative use, more young and middle-aged adults were exposed to long-term sedative prescriptions in 2013 relative to older adults.

Trends in sedative use among community-dwelling adults, 2004 to 2013

Figure 1 depicts age-standardized trends in prevalence of overall (short-term and long-term) sedative use among community-dwelling women and men age 18 and older. All changes in prevalence of overall use were statistically significant at $p<0.05$. The age-standardized proportion of community-dwelling adult women who filled at least one sedative prescription

increased from 14.2% in 2004 to 14.6% in 2013, representing a 3% increase in the age-standardized prevalence rate. Similarly, the age-standardized proportion of community-dwelling adult men who filled sedative prescriptions increased from 8.2% to 8.8% over the period, a 6% increase in the age-standardized prevalence rate.

Stable age-standardized prevalence of overall use of sedatives masked changes in the composition of sedatives prescribed. From 2004 to 2013, the age-standardized proportion of community-dwelling adults dispensed a benzodiazepine declined from 11.2% to 10.0% for women and declined from 6.4% to 5.6% for men. Conversely, the age-standardized proportion of community-dwelling adults dispensed z-drugs increased from 4.6% to 6.6% for women and from 2.7% to 4.1% for men. Note that the sum of benzodiazepine users and z-drug users does not equal the total number of sedative users because 1% of adults filled prescriptions for both benzodiazepines and z-drugs.

Figures 2A and 2B show age-standardized trends in the prevalence of overall sedative use among community-dwelling adults over and under age 65, respectively. From 2004 to 2013, increases in z-drug use offset decreases in benzodiazepine use among community-dwelling adults over age 65; consequently, age-standardized prevalence of sedative use remained stable, at approximately 23% among women and approximately 15% among men. Among adults under age 65, age-standardized increases in z-drug use slightly exceeded age-standardized decreases in use of benzodiazepines. Thus, age-standardized prevalence of using sedatives of any type increased among adults under age 65, from 11.6% to 12.2% among women and from 6.6% to 7.2% among men.

Figures 3A and 3B illustrate age-standardized trends in prevalence of long-term sedative use among community dwelling adults over and under age 65, respectively. All changes in prevalence of long-term benzodiazepine and z-drug use were statistically significant at $p<0.05$. As shown in Figure 3A, the age-standardized prevalence of long-term sedative use among adults aged 65 and older was relative stable at approximately 14% for women and approximately 8% for men. As with trends in overall sedative use among adults aged 65 and older, the relatively stable prevalence of long-term use masked a considerable shift from benzodiazepines to z-drug sedatives.

Community dwelling adults under age 65 experienced similar trends in age-standardized prevalence of long-term sedative use as adults over age 65, albeit at lower levels of utilization, as shown in Figure 3B. The age-standardized proportion of women under age 65 who filled a long-term sedative prescription increased from 4.1% to 4.5% over the period, an approximate 10% increase in the age-standardized prevalence rate. Similarly, the age-standardized proportion of men under age 65 who filled a long-term sedative prescription also increased from 2.5% to 2.9% over the period, representing an approximate 14% increase in the age-standardized prevalence rate. Across the study period, the proportion of sedative users under age 65 who used 90 or more days of them in the given year grew from approximately 36% to 38%.

Variations in sedative use among community-dwelling adults in 2013

Table 2 shows the results of age and sex-stratified and sex-pooled logistic regression analyses for the population stratified at age 65. In all regression models, being older, having poorer health status, having lower income, and being single were all significantly associated with increased odds of long-term use of sedatives. Conversely, having a surname of Chinese or South

Asian origin was associated with lower odds of long-term sedative use in all regression models. Some effects varied across older and younger/middle-aged adult men and women. For example, living in a rural area was associated with increased odds of long-term use of sedatives among younger/middle-aged adult women (Adjusted odds ratio (AOR) = 1.08, 95% Confidence Interval (CI) = 1.04-1.12), but decreased odds among older adult women (AOR = 0.95, 95% CI = 0.91-0.98). Further, living in a rural area had no significant effect on odds of long-term use among either younger/middle-aged or older adult men.

After adjusting for other demographic factors and health status, sex had a statistically significant effect on the odds of long-term sedative use among older adults and younger/middle-aged adults. Younger and middle-aged adult women were associated with 22% higher odds of long-term use of sedatives than men (AOR = 1.22, 95% CI = 1.20-1.24), and older adult women were associated with 59% higher odds than men (AOR = 1.59, 95% CI = 1.57-1.62).

Interpretation

Despite numerous safety concerns and guidelines targeting overprescribing of sedatives (36,44-48), our study shows age-standardized prevalence of long-term use of these medications remained stable among older adults and increased slightly among young and middle-aged adults in BC from 2004 to 2013. Consistent with other studies (8,15,49), our findings illuminate evolving prescribing practices favoring z-drugs over benzodiazepines. Although many physicians believe z-drugs are a safer, more effective alternative to traditional benzodiazepines (49), z-drugs are shown to have similar risk profiles as benzodiazepines, even in younger adult populations (3,50).

Similar to past studies (7,8,14,20,51), we found adults were associated with higher odds long-term sedatives use if they were women, if they had low incomes, and if they had relatively poor health status. We also found having a surname of Chinese or South Asian origin was associated with a protective effect on the odds of long-term sedative use. This finding coincides with other studies documenting ethnic variations in prescription drug use (52,53). Additionally, being in a marriage-like relationship was associated with a statistically significant reduction in odds of long-term use. While some past literature indicates marriage may have a protective effect on risk of chronic use and abuse of prescription drugs (54,55), the opposite has also been true (17).

Long-term sedative use seems to be as much a problem among middle-aged adults as it is among older adults. Though there is a steep age gradient in terms of population prevalence of long-term sedative use, there were actually a higher number of long-term sedative users under age 65 than over age 65. Young and middle-aged chronic sedative users are subject to many of the same risks associated with sedative use as older users; thus their high levels of long-term use should not be ignored. Past efforts to limit chronic sedative use have focused on discontinuing sedative use in older adult populations; future efforts should also consider interventions to limit initiation of sedative use in young and middle-aged adult populations. Ultimately, interventions targeting adults of all ages might result in the most significant gains to patient health.

Study Limitations

While these data are limited in that we are unable to determine whether individuals consumed all prescription drugs dispensed them, those who invest the time and out-of-pocket costs to fill prescriptions likely do so with intent to consume them. Moreover, as some

prescriptions will be written but not filled, this measure is arguably an understatement of the extent of long-term sedative prescribing in BC. While our findings mirror recent trends in total benzodiazepine and z-drug dispensations from another Canadian province (8), it is important to note that they are based on BC's population and may not be generalizable to other jurisdictions with different prescription monitoring programs and deprescribing strategies in place.

Conclusions

Long-term benzodiazepine and z-drug dispensing continues to be a significant problem in BC, as shown by the stable dispensations among older adults and increasing dispensations among younger and middle-aged adults from 2004 to 2013. Our results suggest that numerous warnings and policies to reduce long-term prescribing of sedatives to older adults may have only resulted in the substitution of benzodiazepines with z-drug sedatives, a harmful alternative. Our study also found what might be a sleeping giant in the area of sedative prescribing: the majority of long-term sedative users are under age 65. Long-term sedative use appears to be common and increasing slightly among middle-aged adults. Future de-prescribing efforts might best achieve their goals by targeting the middle-aged adults who fill a significant proportion of total long-term sedative prescriptions.

Disclaimer

All inferences, opinions, and conclusions drawn in this report are those of the authors, and do not reflect the opinions or policies of Population Data BC or the data stewards.

Competing interests

The authors have no competing interests to declare.

Funding

This study was funded by the Canadian Institute for Health Research and, in part, by a Banting Postdoctoral Fellowship [KS]. The funding body was not involved in the study design, analysis, interpretation of the data, or writing of this manuscript.

Authors' contributions

All authors were involved in the conceptualization and design of the study and the interpretation of data. DW conducted the analysis and drafted the manuscript. EG and KS revised the manuscript for important intellectual content. SM acquired the data and revised the manuscript for important intellectual content. All authors give final approval of the version to be published and agree to act as guarantors of the work.

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Figures and Tables

Table 1: Characteristics of different sedative user groups among community-dwelling women and men aged 18 and older, British Columbia, 2013

Variable	Non-Users of Sedatives		Short-term Sedatives Users		Long term Sedatives Users	
	N	%	N	%	N	%
Population	2,837,834	88.2	206,059	6.4	172,276	5.4
Using Benzodiazepines	0	0.0	142,061	68.9	98,107	57.0
Using Z-drugs	0	0.0	79,053	38.4	87,840	51.0
Sex						
Women	1,411,861	49.8	132,318	64.2	109,264	63.4
Men	1,425,973	50.3	73,741	35.8	63,012	36.6
Age						
18-44	1,246,832	43.9	66,602	32.3	22,459	13.0
45-64	1,028,052	36.2	86,474	42.0	71,086	41.3
65-84	487,515	17.2	47,057	22.8	65,313	37.9
85+	75,435	2.7	5,926	2.9	13,418	7.8
Count of Major ADGs						
0 Major ADGs	1,938,119	68.3	94,655	45.9	54,917	31.9
1-2 Major ADG	809,027	28.5	90,995	44.2	88,901	51.6
3+ Major ADGs	90,688	3.2	20,409	9.9	28,458	16.5
Count of Minor ADGs						
0-1 Minor ADGs	996,680	35.1	16,131	7.8	8,700	5.1
2-3 Minor ADGs	866,290	30.5	51,610	25.1	34,445	20.0
4-5 Minor ADGs	578,867	20.4	60,936	29.6	48,277	28.0
6+ Minor ADGs	395,997	14.0	77,382	37.6	80,854	46.9
Income Quintile						
Lowest	564,644	19.9	49,035	23.8	55,597	32.3
Second	589,608	20.8	38,898	18.9	36,131	21.0
Third	545,222	19.2	33,156	16.1	25,568	14.8
Fourth	574,352	20.2	37,345	18.1	25,379	14.7
Fifth	564,008	19.9	47,625	23.1	29,601	17.2
Relationship Status						
Marriage-like relationship	1,553,729	54.8	114,960	55.8	88,367	51.3
Single	1,284,105	45.3	91,099	44.2	83,909	48.7
Ethnicity						
Other	2,357,019	83.1	185,958	90.3	161,502	93.8
Chinese	346,159	12.2	11,033	5.4	6,733	3.9
South Asian	134,656	4.8	9,068	4.4	4,041	2.4
Neighborhood Urbanization						
Urban	2,682,538	94.5	194,214	94.3	161,061	93.5
Rural	155,296	5.5	11,845	5.8	11,215	6.5

Note: Long-term sedative use defined by the filling of prescriptions containing a total of 90 or more days' supply of sedative during the calendar year. Drugs included as benzodiazepines and

z-drugs are provided in Appendix A. Aggregated Diagnostic Groups (ADGs) map ICD-9 and ICD-10 codes into 32 mutually-exclusive groups based on similar levels of severity, persistence, and health resource requirements. Of these groups, 8 have very high expected resource use and are labeled as major ADGs. Remaining ADGs are considered minor. Marriage-like relationships include common-law and married relationships between two same sex or opposite sex adults.

Figure 1: Age-standardized prevalence of overall (short-term and long-term) sedative use among community-dwelling women and men aged 18 and older, British Columbia, 2004 to 2013

Figure 2A: Age-standardized prevalence of overall sedative use among community-dwelling women and men aged 65 and older, British Columbia, 2004 to 2013

Figure 2B: Age-standardized prevalence of overall sedative use among community-dwelling women and men aged 18 to 64, British Columbia, 2004 to 2013

Figure 3A: Age-standardized prevalence of long-term sedative use among community-dwelling women and men aged 65 and older, British Columbia, 2004 to 2013

Figure 3B: Age-standardized prevalence of long-term sedative use among community-dwelling women and men aged 18 to 64, British Columbia, 2004 to 2013

Table 2: Adjusted odds ratios for likelihood of long-term sedative use among community-dwelling British Columbians, age and sex-stratified and sex-pooled results

Variable	Women				Men							
	Young/Middle-Aged Adults (18-64)		Older Adults (65+)		Young/Middle-Aged Adults (18-64)		Older Adults (65+)		Young/Middle-Aged Adults (18-64)		Older Adults (65+)	
	Odds	95% CI	Odds	95% CI	Odds	95% CI	Odds	95% CI	Odds	95% CI	Odds	95% CI
Sex												
Men	-	-	-	-	-	-	-	-	Ref.	-	Ref.	-
Women	-	-	-	-	-	-	-	-	**1.22**	(1.20,1.24)	**1.59**	(1.57,1.62)
Age												
18-44	Ref.	-	-	-	Ref.	-	-	-	Ref.	-	-	-
45-64	**3.53**	(3.46,3.60)	-	-	**2.57**	(2.50,2.64)	-	-	**3.14**	(3.09,3.19)	-	-
65-84	-	-	Ref.	-	-	-	Ref.	-	-	-	Ref.	-
85+	-	-	**1.10**	(1.07,1.13)	-	-	**1.10**	(1.06,1.14)	-	-	**1.09**	(1.07,1.12)
Count of Major ADGs												
0 Major ADGs	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
1-2 Major ADG	**1.86**	(1.82,1.89)	**1.39**	(1.36,1.42)	**2.02**	(1.97,2.07)	**1.53**	(1.48,1.59)	**1.92**	(1.90,1.95)	**1.43**	(1.41,1.46)
3+ Major ADGs	**3.76**	(3.64,3.89)	**1.83**	(1.77,1.89)	**3.26**	(3.13,3.39)	**2.04**	(1.96,2.13)	**3.54**	(3.45,3.63)	**1.90**	(1.85,1.94)
Count of Minor ADGs												
0-1 Minor ADGs	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
2-3 Minor ADGs	**3.11**	(2.98,3.25)	**2.84**	(2.69,3.00)	**3.59**	(3.45,3.74)	**2.64**	(2.47,2.83)	**3.35**	(3.25,3.45)	**2.77**	(2.65,2.88)
4-5 Minor ADGs	**5.21**	(4.99,5.43)	**4.15**	(3.94,4.38)	**6.34**	(6.08,6.61)	**3.94**	(3.68,4.21)	**5.70**	(5.53,5.87)	**4.08**	(3.91,4.25)
6+ Minor ADGs	**9.42**	(9.04,9.83)	**6.96**	(6.61,7.33)	**11.70**	(11.2,12.21)	**6.59**	(6.16,7.04)	**10.29**	(9.99,10.6)	**6.83**	(6.56,7.12)
Income Quintile												
Lowest	**1.33**	(1.29,1.36)	**1.23**	(1.18,1.27)	**1.57**	(1.52,1.63)	**1.14**	(1.10,1.19)	**1.41**	(1.38,1.44)	**1.19**	(1.16,1.22)
Second	**1.08**	(1.05,1.11)	**1.13**	(1.09,1.17)	**1.19**	(1.15,1.23)	**1.08**	(1.03,1.12)	**1.12**	(1.10,1.15)	**1.11**	(1.08,1.14)
Third	0.97	(0.95,1.00)	1.01	(0.97,1.05)	**1.05**	(1.01,1.09)	0.98	(0.94,1.02)	1.01	(0.98,1.03)	1.00	(0.97,1.03)
Fourth	0.99	(0.96,1.02)	0.98	(0.94,1.02)	1.00	(0.97,1.04)	**0.93**	(0.89,0.97)	0.99	(0.97,1.02)	0.96	(0.93,0.98)
Fifth	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Relationship Status												
Marriage-like relationship	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Single	**1.40**	(1.37,1.43)	**1.10**	(1.08,1.13)	**1.61**	(1.57,1.65)	**1.29**	(1.25,1.33)	**1.48**	(1.46,1.50)	**1.16**	(1.14,1.19)
Ethnicity												

Variable	Women				Men				Young/Middle-Aged Adults (18-64)		Older Adults (65+)	
	Young/Middle-Aged Adults (18-64)		Older Adults (65+)		Young/Middle-Aged Adults (18-64)		Older Adults (65+)					
	Odds	95% CI	Odds	95% CI	Odds	95% CI	Odds	95% CI	Odds	95% CI	Odds	95% CI
Other	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Chinese	**0.29**	(0.28,0.31)	**0.47**	(0.45,0.49)	**0.34**	(0.32,0.36)	**0.55**	(0.52,0.59)	**0.31**	(0.30,0.32)	**0.50**	(0.48,0.52)
South Asian	**0.35**	(0.33,0.37)	**0.44**	(0.41,0.47)	**0.53**	(0.50,0.57)	**0.60**	(0.55,0.65)	**0.42**	(0.40,0.43)	**0.49**	(0.47,0.52)
Neighborhood Urbanization												
Urban	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Rural	**1.08**	(1.04,1.12)	**0.95**	(0.91,0.98)	0.98	(0.93,1.02)	0.98	(0.94,1.03)	**1.04**	(1.01,1.07)	**0.96**	(0.93,0.99)

Note: Long-term sedative use defined by the filling of prescriptions containing a total of 90 or more days' supply of sedative during the calendar year. Aggregated Diagnostic Groups (ADGs) map ICD-9 and ICD-10 codes into 32 mutually-exclusive groups based on similar levels of severity, persistence, and health resource requirements. Of these groups, 8 have very high expected resource use and are labeled as major ADGs. Remaining ADGs are considered minor. Marriage-like relationships include common-law and married relationships between two same sex or opposite sex adults. Drugs included as benzodiazepines and z-drugs are provided in Appendix A. We report 95% confidence intervals (CIs). Odds ratios are adjusted for all listed variables.

Appendix A

ATC Level 5 codes identifying benzodiazepine and z-drug dispensations

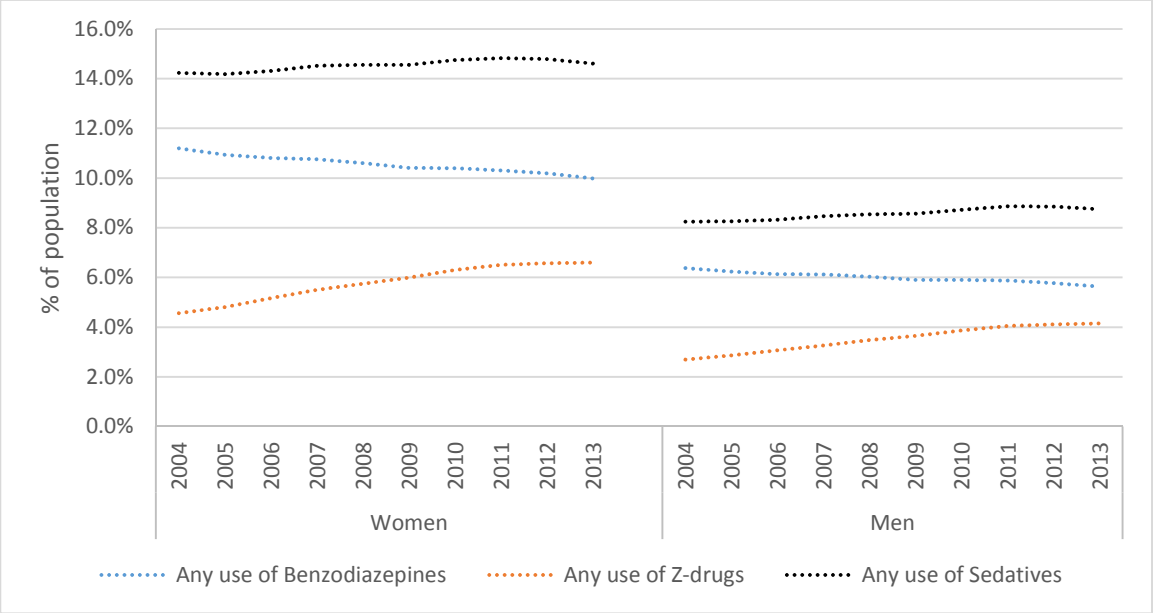
ATC 5 CODE	ATC 5 NAME	Drug Class
N03AE01	CLONAZEPAM	Benzodiazepines
N05BA01	DIAZEPAM	Benzodiazepines
N05BA02	CHLORDIAZEPOXIDE	Benzodiazepines
N05BA05	CLORAZEPATE POTASSIUM	Benzodiazepines
N05CD01	FLURAZEPAM	Benzodiazepines
N05BA04	OXAZEPAM	Benzodiazepines
N05BA06	LORAZEPAM	Benzodiazepines
N05BA12	ALPRAZOLAM	Benzodiazepines
N05CD05	TRIAZOLAM	Benzodiazepines
N05CD07	TEMAZEPAM	Benzodiazepines
N05BA08	BROMAZEPAM	Benzodiazepines
N05CD02	NITRAZEPAM	Benzodiazepines
N05CF01	ZOPICLONE	Z-drugs
N05CF02	ZOLPIDEM	Z-drugs
N05CF03	ZALEPLON	Z-drugs

Appendix B

Supplemental Figure 1A: Age profile of the population of community-dwelling, long-term sedative users, women aged 18 and older, British Columbia, 2013

Supplemental Figure 1B: Age profile of the population of community-dwelling, long-term sedative users, men aged 18 and older, British Columbia, 2013

Figure 1: Age-standardized prevalence of overall (short-term and long-term) sedative use among community-dwelling women and men aged 18 and older, British Columbia, 2004 to 2013



Note: Sedative use defined by the filling of one or more sedative prescription during the calendar year. Age-standardization performed using the 2013 population in four age categories (18–44, 45–64, 65–84, and 85+).

Figure 2A: Age-standardized prevalence of overall sedative use among community-dwelling women and men aged 65 and older, British Columbia, 2004 to 2013

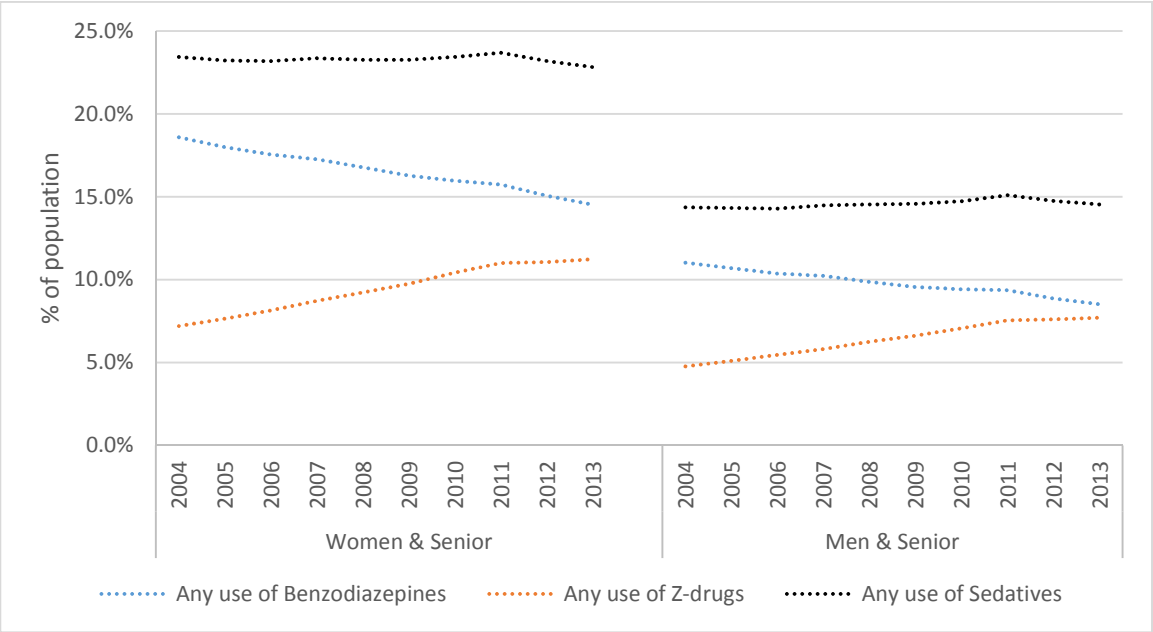
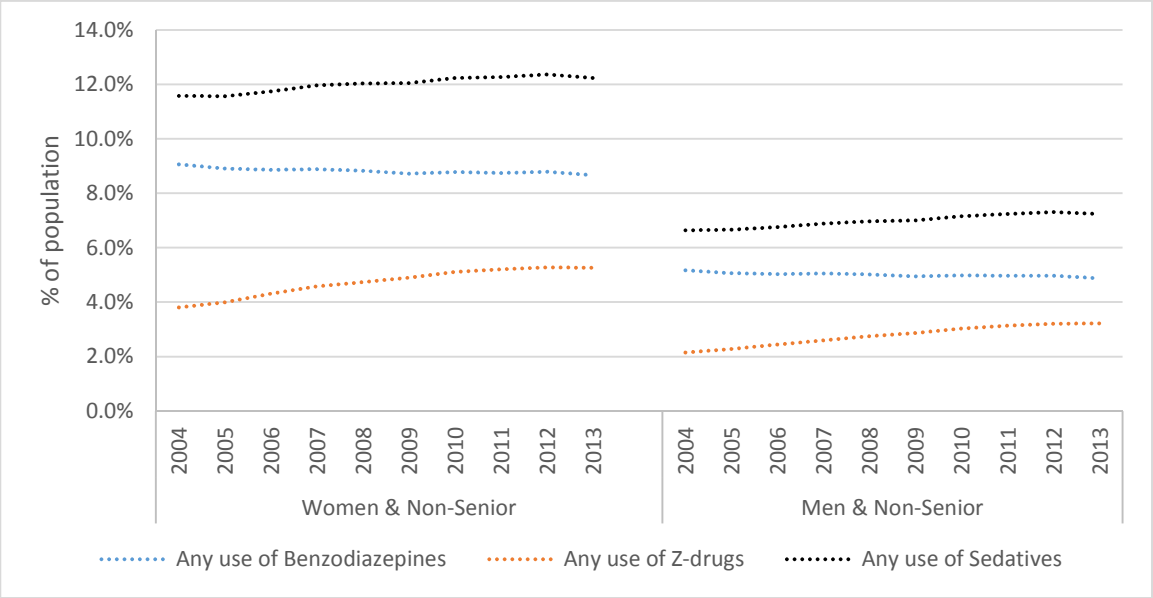


Figure 2B: Age-standardized prevalence of overall sedative use among community-dwelling women and men aged 18 to 64, British Columbia, 2004 to 2013



Note: Sedative use defined by the filling of one or more sedative prescription during the calendar year. Age-standardization performed using the 2013 population in four age categories (18–44, 45–64, 65–84, and 85+).

Figure 3A: Age-standardized prevalence of long-term sedative use among community-dwelling women and men aged 65 and older, British Columbia, 2004 to 2013

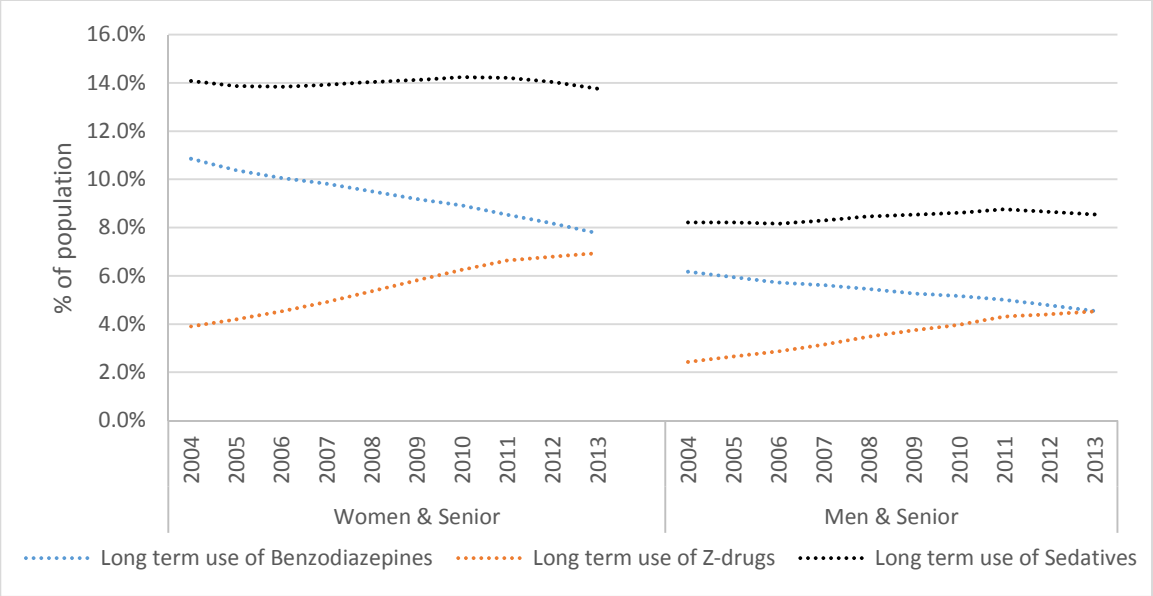
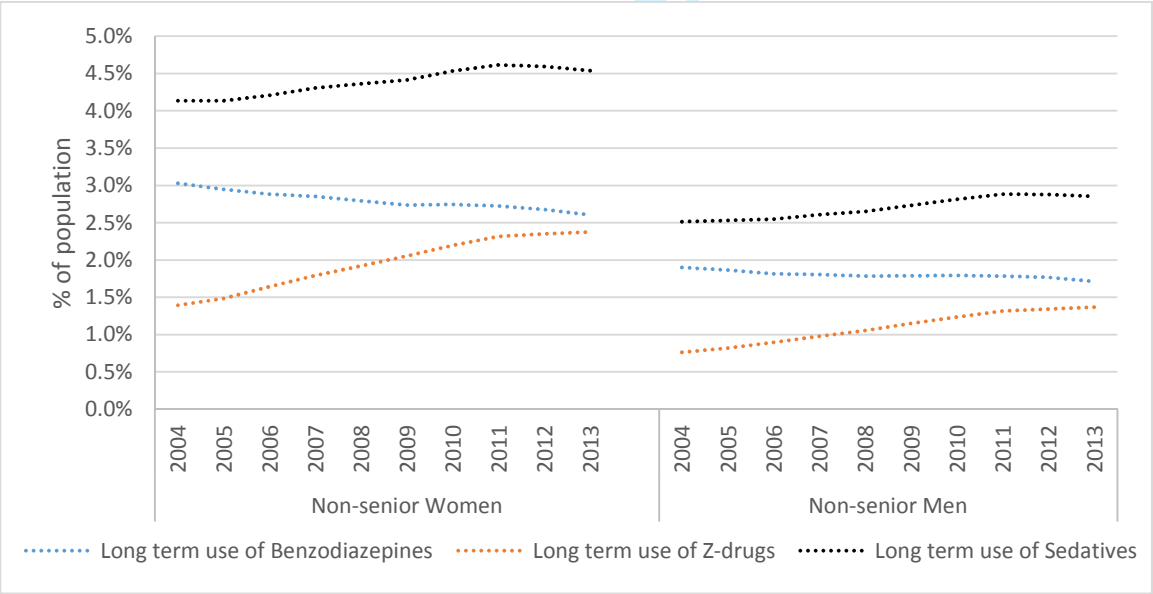
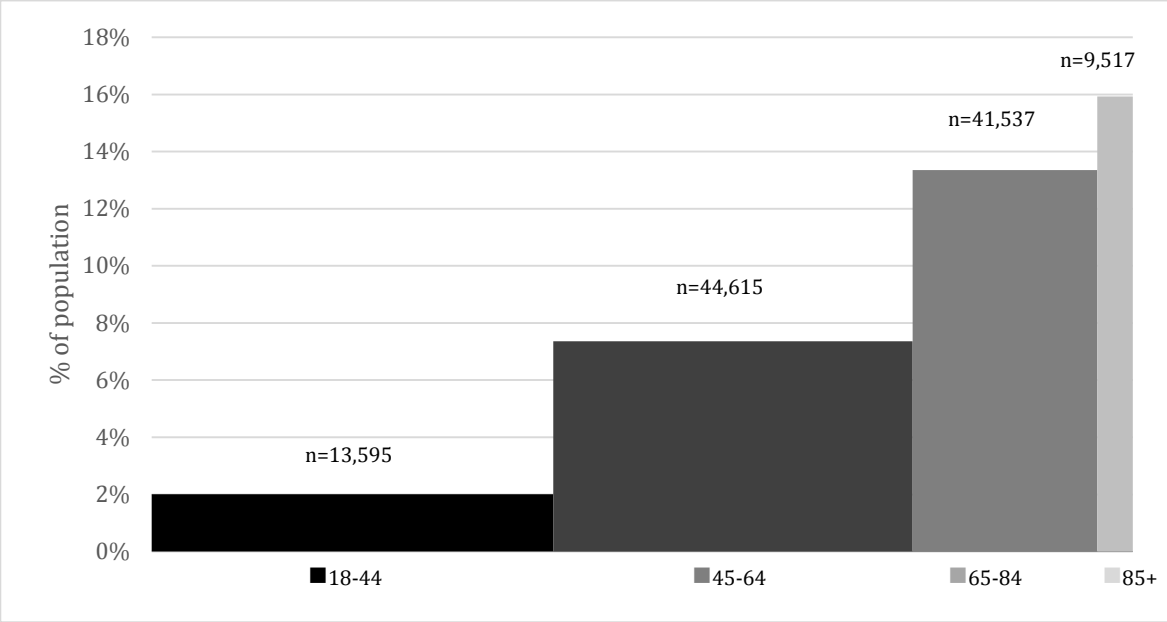


Figure 3B: Age-standardized prevalence of long-term sedative use among community-dwelling women and men aged 18 to 64, British Columbia, 2004 to 2013

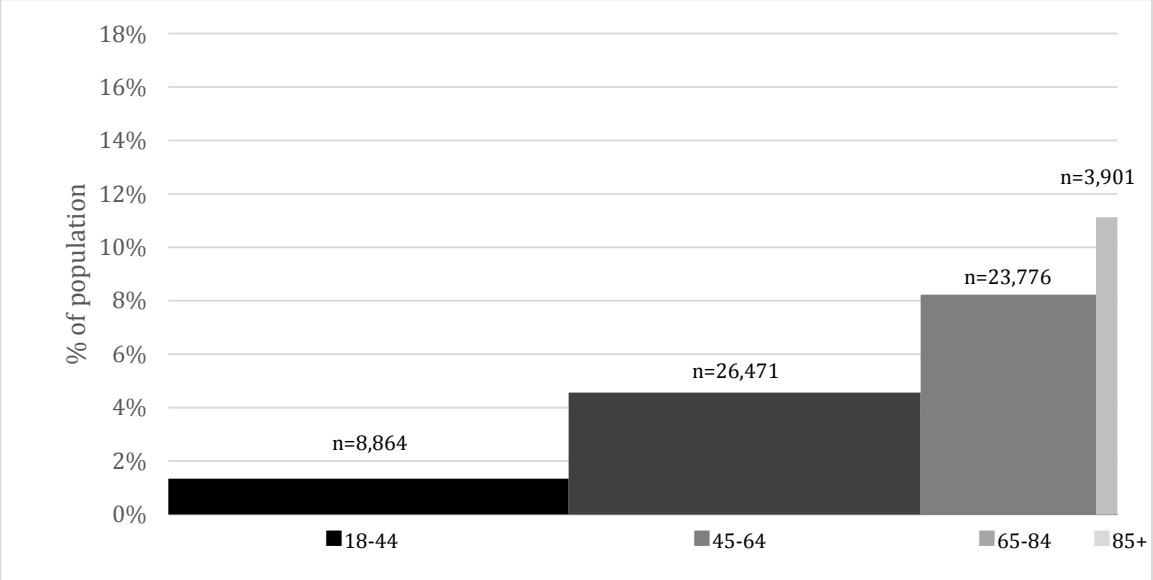


Note: Long-term sedative use defined by the filling of prescriptions containing a total of 90 or more days' supply of sedative during the calendar year. Age-standardization performed using the 2013 population in four age categories (18–44, 45–64, 65–84, and 85+).

Supplemental Figure 1A



Supplemental Figure 1B



Note: Long-term sedative use defined by the filling of prescriptions containing a total of 90 or more days' supply of sedative during the calendar year. Bar width scaled by population size and n is equal to the number of long-term sedative users in each age group

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 & 2	Title: A population-based **longitudinal analysis** of long-term sedative use among community-dwelling adults Also see Methods in Abstract.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	See Methods & Results in Abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3	Introduction – paragraph 1
Objectives	3	State specific objectives, including any prespecified hypotheses	3	Introduction – paragraph 2
Methods				
Study design	4	Present key elements of study design early in the paper	4	See Methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4	See Methods, paragraph 1
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4-5	See Methods – Data and Derived Variables sections **Population-based analysis**
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6	See Definitions and Statistical Analysis sections in Methods
Data sources/	8*	For each variable of interest, give sources of data and details of methods of assessment	4-5	See Data, Derived Variables,

measurement		(measurement). Describe comparability of assessment methods if there is more than one group		and Definitions sections in Methods.
Bias	9	Describe any efforts to address potential sources of bias	4-6	See exclusion criteria throughout Data and Derived Variables section of Methods. See discussion of covariates included in Statistical Analysis section of Methods to account for observable confounding.
Study size	10	Explain how the study size was arrived at	4-5	See exclusion criteria throughout Data and Derived Variables section of Methods.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6	See Definitions is Methods.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6	See Statistical Analysis section in Methods
		(*b*) Describe any methods used to examine subgroups and interactions	6	See Statistical Analysis section in Methods where we explain stratification by sex and age groups of young/middle-aged adults and older adults.
		(*c*) Explain how missing data were addressed	5	See description of exclusion of missing household and income data in Derived Variables section of Methods.
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A – Population-based analysis	
		(*e*) Describe any sensitivity analyses	N/A	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7	See paragraph 1 of Results
		(b) Give reasons for non-participation at each stage	5-6	Described in text in Methods
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9	See Variation in sedative use among community dwelling adults in 2013 section of Results
		(b) Indicate number of participants with missing data for each variable of interest	N/A – as described in Methods, excluded these participants from analysis	

		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	7-9	*See Results. Also see Table 1 and Figures.*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10	Adjusted odds ratios with confidence intervals presented in Results and in Table 2.
		(*b*) Report category boundaries when continuous variables were categorized		N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		N/A

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7-9	Age-standardized trends analysis is reported in Results.
Discussion				
Key results	18	Summarise key results with reference to study objectives	10-11	Paragraphs 1, 2, and 3 of Interpretation
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-12	See Study Limitations section of Results.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12	See Conclusions section of Results
Generalisability	21	Discuss the generalisability (external validity) of the study results	12	See Study Limitations section of Results.
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13	Funding information provided.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.